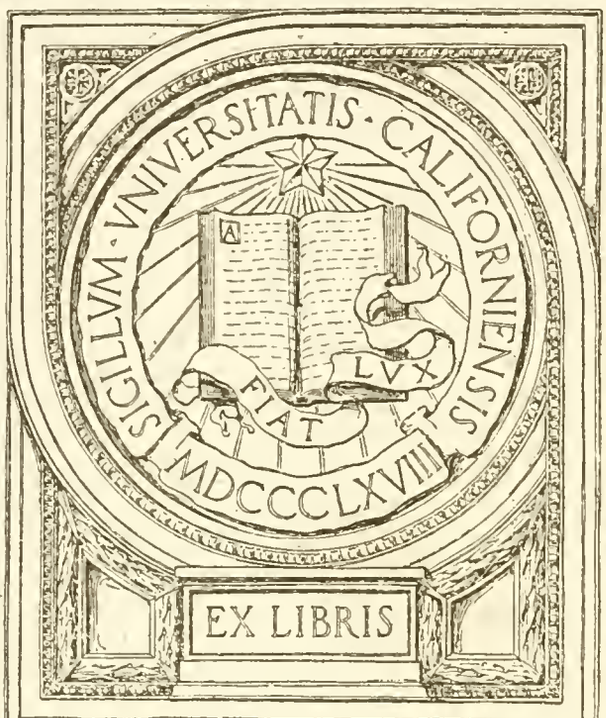


Vol. LXXXVI, No. 3 MARCH, 1915

THE POPULAR SCIENCE MONTHLY

EDITED BY J. McKEEN CATTELL

PACIFIC COAST NUMBER

Edited by HARRY BEAL TORREY

Astronomy on the Pacific Coast. Professor RUSSELL TRACY CRAWFORD 209

The Biological Laboratories of the Pacific Coast. Professor WILLIAM E. RITTER 223

The Last Wild Tribe of California. Professor T. T. WATERMAN . . 233

Extinct Faunas of the Mohave Desert, their Significance in a Study of the Origin and Evolution of Life in America. Professor JOHN C. MERRIAM 245

Insects of the Pacific. Professor VERNON L. KELLOGG 265

The Physiological Aspects of California for the Botanist. Professor GEORGE J. PEIRCE 270

Social Legislation on the Pacific Coast. Professor WILLIAM F. OGBURN 276

The Volcanic Activity of Lassen Peak, California. Professor RULIFF S. HOLWAY 290

The Progress of Science:

Science on the Pacific Coast; The Organization of the Pacific Division of the American Association for the Advancement of Science; The California Meeting of the American Association 307

THE SCIENCE PRESS

LANCASTER, PA. GARRISON, N. Y.

NEW YORK: SUB-STATION 84

SINGLE NUMBER, 30 CENTS YEARLY SUBSCRIPTION, $3.00

SCHOOL AND SOCIETY

A weekly journal covering the whole field of education in relation to the problems of American democracy

---

SCHOOL AND SOCIETY began publication on January 2, 1915, under the editorship of Dr. J. McKeen Cattell, professor of psychology in Columbia University and the Teachers College, editor of "Science," "The Popular Science Monthly" and "The American Naturalist." The journal will follow the general lines that have made "Science" of service in the sciences, cooperating with publications in special fields, aiming to become the professional journal for those engaged in the work of our lower and higher schools, and to be of interest to the wider public for whom education is of vital concern. It will emphasize the relations of education to the social order, scientific research in education and its applications, freedom of discussion, and reports and news of events of educational interest.

A weekly journal of education of this character, which at present does not exist in any country, has been under consideration for some time, but the plans were postponed on the outbreak of the war. Finally, however, it appeared that if the European nations must neglect their educational interests it is all the more important that we should do the best we can in America, and the journal has begun publication at a time when there is thrust on this country great responsibility and great opportunity.

The publishers hope that those who read this announcement will subscribe to the journal in order to assure its usefulness and success. There will be published two volumes a year, each containing over 800 double column pages of reading matter well printed on good paper. The annual subscription price is $3.00, the cost of a volume, $1.50, and the charge for single copies, 10 cents.

THE SCIENCE PRESS

LANCASTER, PA. GARRISON, N. Y.

SUB-STATION 84, NEW YORK CITY

To THE SCIENCE PRESS
Lancaster, Pa., and Garrison, N. Y.

Please enter my name as a subscriber for ***School and Society,*** *for which I* *enclose* / *will send* *check or money order for three dollars.*

Name.....

Address .....

Date..... .....

THE
POPULAR SCIENCE
MONTHLY.

MARCH, 1915

ASTRONOMY ON THE PACIFIC COAST

By Professor RUSSELL TRACY CRAWFORD

THIS subject brings instantly to the mind's eye the Lick Observatory on Mount Hamilton, and the Solar Observatory on Mount Wilson, as they are two of the greatest astronomical observatories in the world, and probably the best generally known of all. The one is an asset of the Pacific coast, probably accidentally, the other was placed there as a result of mature deliberation after thorough investigation of many locations. In addition to these two wonderful institutions there is in process of construction a third great observatory near Victoria, B. C., which, when completed, will contain the second largest reflecting telescope in the world. It is evident, therefore, that conditions on this coast are extremely favorable for developing the practical side of astronomy. On the other hand, the theoretical side of the subject is by no means to be lost sight of, as I shall point out.

In the early days before the erection of the Lick Observatory, the only astronomical work on the Pacific Coast was that done by the U. S. Coast and Geodetic Survey under the able direction of the late Professor George Davidson. This was not astronomical work as such, but merely the solving of such astronomical practical problems as were incident to the regular work of the survey. The first real scientific astronomical investigations came with the advent of the Lick Observatory.

This institution is the gift of James Lick, a California pioneer, who had amassed a fortune of several million dollars.

> On July 16, 1874, he executed a deed of trust which devoted the entire sum to public purposes.

Among the provisions of the deed is one that directed the trustees

> to expend the sum of seven hundred thousand dollars for the purpose of constructing . . . a powerful telescope, superior to and more powerful than any telescope ever yet made, with all the machinery appertaining thereto. . . .

He left the trustees certain discretionary powers as to its location

LICK OBSERVATORY FROM THE EAST.

with the proviso, however, that "the same must be located within the state of California."

Just why Lick provided for this telescope and observatory will probably never be known. While I can not recall my authority, I have a very distinct recollection of having heard it stated that the idea was first suggested to him and frequently urged upon him by Professor George Davidson. Concerning this point, however, the director of the Lick Observatory writes,[1]

> The question, "What induced Lick to provide for a great telescope?" has never been satisfactorily answered; but there is no reason to doubt that he came to this determination without conscious suggestion from others.

After having several sites tested the trustees decided upon Mount Hamilton, California, as the best location for the observatory. Active work was begun in 1879, and the observatory was completed and ready for regular work in 1888. The plant cost all but $90,000 of the amount set aside for it. The observatory and this balance were turned over to the regents of the University of California by the trustees June 1, 1888; and since then it has been an integral part of the university.

The principal instruments of this observatory are the great 36-inch refractor, a 6-inch Repsold meridian circle, provided by the Lick Trust, and the 36¼-inch reflector, a gift from Edward Crossley, Esq., of England. Besides these there is a host of smaller instruments and auxiliary apparatus. I can not go into details here concerning the instruments, but I wish to mention one which has an important bearing upon the subject of this article. It is that the magnifying power of the great refractor may be made to be as much as 3,000 diameters. When one considers that everything in the line of sight of the telescope is magnified by this amount, it becomes evident that, to be efficient, the telescope must be located at a site where the atmosphere through which the line of sight passes is extremely steady, for any little atmospheric disturbance will be magnified to this amount and destroy what is called the "seeing," giving a poorly defined image of the star or object under observation. And it is principally on account of the splendid atmospheric conditions on the Pacific coast, especially on some of the moderately high mountains, which make *excellent* "seeing" possible that observational astronomy here has been able to make such tremendous strides.

For the efficient use of a great telescope its location must be in a region of great atmospheric calm, where the sky is clear and transparent, with little wind, and where the number of days and nights of a year during which such conditions do not exist is small. For some reason, the "seeing" conditions at Mount Hamilton during the day are not of the best; but at night excellent conditions are found on a large

[1] "A Brief Account of the Lick Observatory of the University of California," prepared by the Director of the Observatory. Fourth edition, 1914.

LICK OBSERVATORY FROM THE WEST.

majority of the nights of a year, and many nights yield "seeing" that might be considered perfect. A glance at the illustrations showing the mountain as seen from the east and from the west will make it evident at once why these conditions obtain. With the exception of a saddle running eastward, the land slopes away rapidly from the summit down into deep valleys, so that there is but little opportunity for heat waves radiated from surrounding land to mount to the atmosphere above the observatory and create atmospheric disturbances. The mountain is not so very high (4,209 feet above mean sea level), but it is high enough to hold the observatory in an atmosphere free from dust, smoke and fog. Being near the ocean, fogs are very frequent at certain seasons over the valleys in this region. It is seldom, however, that they mount high enough to envelop the observatory. Many evenings and early mornings fog completely fills the surrounding valleys, so that the observatory seems to rest on an island in a vast sea of fog. Often peaks only a few hundred feet lower than Mount Hamilton are covered by the fog, yet the work with the great instruments is uninterrupted. The picture "Fog in the Valleys at Sunset" gives a better idea of this condition than I can describe. In such a location as this the 36-inch refractor can be used with its maximum power a large portion of the time. In less favorable localities even larger instruments would not be so efficient.

It is one thing to have an excellent plant, and it is another thing to have men skillful enough to operate such a plant effectively. A very proficient marksman can not do very much damage with a blunderbuss,

and one unskilled will not be able to produce any good results from the best modern artillery; but an expert behind a Krupp can produce a high percentage of effective hits. And so it is with the Lick Observatory. Not only is it a wonderful engine of science, but also it has been very fortunate in the astronomers who have operated it.

I can not here go into the details of all that has been done at the Lick Observatory, but the following extracts from "A Brief Account of the Lick Observatory of the University of California," prepared by the director of the observatory, 1914, give an idea of the principal things of general interest that have been accomplished in the quarter of a century of its existence:

1. To the four bright satellites of Jupiter discovered by Galileo in 1610, the Lick Observatory has added four satellites.

2. Twenty-nine comets have been discovered. Nineteen of these were unexpected, and ten were periodic comets whose return had been predicted.

3. The first great success in photographing comets and the Milky Way were made here.

4. About 4,400 double star systems have been discovered.

5. Irregularities in the motions of the first magnitude star *Procyon* had led the celebrated German astronomer Bessel, three quarters of a century ago, to predict that *Procyon* had a companion sun revolving around it. This companion was discovered with the Lick telescope.

6. Spectographic observations of stellar motions have shown that the solar system is traveling through space, with reference to the general stellar system, at a speed of about twelve miles per second.

Fog in the Valleys at Sunset, Mt. Hamilton.

7. The Mount Hamilton and Santiago[2] spectographic observations of stellar motions have shown that stars effectively young are traveling slowly, middle-aged stars more rapidly, and old stars more rapidly still; that is, that the velocities of the stars increase with their effective ages.

8. Observations have established that those nebulæ known as planetary nebulæ are traveling through space with average speeds even higher than the average speeds of the stars. It had previously been supposed that these nebulæ represented a stage of existence antecedent to the stellar age. The high velocities of these objects have created the opinion that they have more probably been formed from stars which have been overtaken by catastrophes, such as collisions with other celestial objects.

9. The North Pole Star was found to be a triple star, in 1899, by means of spectrographic observations. The first magnitude star *Capella* was discovered to consist of two stars revolving around their center of mass in 104.1 days, the two nearly equal components being inseparable in our largest telescopes.

10. In the same manner about 250 spectroscopic binary stars have been found at Mount Hamilton and Santiago.

11. A study of the orbits of spectroscopic binary stars has established that the component stars in a system whose spectrum indicates early age are relatively very close together, requiring very short periods of revolution, and that the orbits are nearly circular. In systems whose spectra show them to be of greater effective ages, the distances separating the components are successively greater, on the average, and their orbits are more eccentric. The observed facts on the subject are fully confirmative of existing mathematical theories of the evolution of double star systems.

12. The Crossley reflecting telescope established for the first time the tremendous advantage of this form of telescope in the photography of certain classes of celestial objects, such as nebulæ, star clusters, etc.

13. Before the Crossley reflector was in use about 10,000 nebulæ had been discovered at various observatories. A few dozens of these were known to be spiral in form. The Crossley photographs led to the discovery of many hundreds of additional nebulæ in the extremely small part of the sky covered by the photographs. It was a simple matter to calculate that certainly 120,000 and possibly half a million nebulæ await discovery whenever time can be spared for the Crossley reflector to undertake this work. These photographs led to the unexpected discovery that a majority of the nebulæ are of spiral form—undoubted evidence of their rotation.

14. The extensive series of photographs of the minor planet *Eros* and surrounding stars, with the Crossley reflector, led to a new and accurate determination of the distance from the earth to the sun.

15. Eight total solar eclipses have been successfully observed by expeditions whose expenses were defrayed by friends of the observatory.

16. It has been shown that the new stars appearing in recent years have been converted into nebulæ, and later, in many cases, into extremely faint stars of apparently normal condition.

17. Many thousands of extremely accurate positions of the stars have been secured with the meridian circle.

18. Very extensive observations of double stars, comets, planets, and satellites have been made.

19. A large number of orbits have been computed for visual double stars, spectroscopic binary stars, comets, and asteroids.

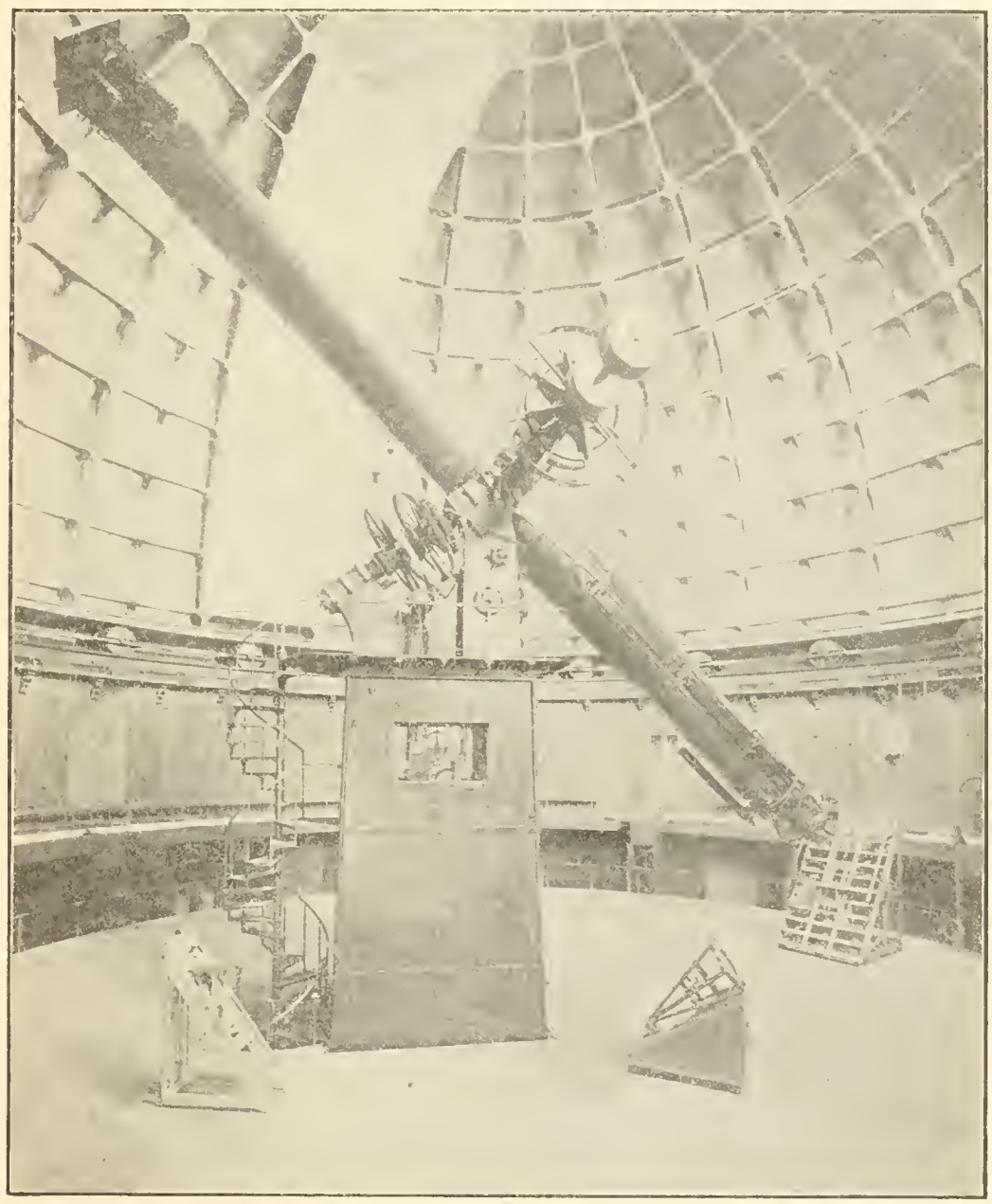
20. Extensive additions have been made to our knowledge of the spectra of nebulæ, comets, new stars, and stars of special interest.

[2] Santiago, Chile, is the location of the D. O. Mills Observatory, which is administered by the director of the Lick Observatory.

21. Important studies of the spectra of spiral nebulæ and star clusters have been inaugurated.

22. An atlas of the moon was made in the first year of the observatory's existence, on the basis of photographs obtained with the large telescope.

23. The motions of approach and recession of about 1,500 naked-eye stars, distributed over the entire sky, have been observed with the 36-inch refractor at Mount Hamilton and the D. O. Mills reflector at Santiago.



THE 36-INCH REFRACTOR OF THE LICK OBSERVATORY.

24. Spectroscopic observations at Mount Hamilton and on the summit of Mount Whitney have shown that the atmosphere of *Mars* is of low density, probably much less dense at the surface of *Mars* than the earth's atmosphere is at the summit of the highest peak in the Himalaya Mountains. These observations have established likewise that the quantity of water vapor in the atmosphere of *Mars* above, say, a square mile of its surface, must be very slight as compared with the quantity of water vapor in the earth's atmosphere above an equal area.

MOUNT WILSON SOLAR OBSERVATORY.

The wise economical policy of this observatory is to engage principally in those investigations which can not be carried on with smaller and less effective instruments. Much that could be done there is left to smaller institutions. The great instruments are used only for the problems that demand their great power. And these are quite sufficient to keep them in constant use.

Turning now to the Mount Wilson Solar Observatory we find a unique institution. As its name implies, it is an observatory erected primarily for the study of the sun.

> In 1902, Dr. S. P. Langley addressed a communication to the Carnegie Institution recommending the establishment of an observatory at a very high altitude for the special purpose of measuring the solar radiation.

This recommendation resulted ultimately in the erection of the Solar Observatory by the Carnegie Institution by which it is supported. Various sites in Arizona and in southern California were tested, and the summit of Mount Wilson (nearly 6,000 feet above sea-level) near Pasadena in southern California was selected. In the choice of a site for this observatory excellent "seeing" conditions in day time as well as at night were of primary importance. Such conditions were found to exist on Mount Wilson.

For director of the observatory a very wise choice was made in Dr. George E. Hale. It is due principally to his genius and untiring efforts that this wonderful plant has been designed and brought to its present high state.

Dr. Hale points out that the term "solar observatory" is to be used in a broad sense,

> since it is not intended to exclude from the program certain investigations of stars which are of fundamental importance in any general study of the problem of stellar evolution. For the sun is a star, comparable in almost every respect with many other stars in the heavens, and rendering possible, through an intimate knowledge of its own phenomena, the solution of some of the most puzzling questions in the general problem of stellar evolution. Conversely, however, the stars are suns, and if we would know the past and future conditions of the sun, we must examine into the physical condition of stars which represent earlier and later stages of development. It will be seen that there is ample ground for the inclusion in the equipment of a solar observatory of certain instruments especially designed for the study of stellar problems.

Such an observatory, whose primary object is "to apply new instruments and methods of research in a study of the physical elements of the problem of stellar evolution," must of necessity have as complementary parts of its equipment a physical laboratory and an adequate machine shop. These two parts have been supplied and are located in Pasadena. Here not only are smaller pieces of apparatus made and repaired, but also the enormous discs of glass for the 60-inch and the 100-inch reflectors have been figured and tested.

The instrumental equipment of the solar observatory is naturally

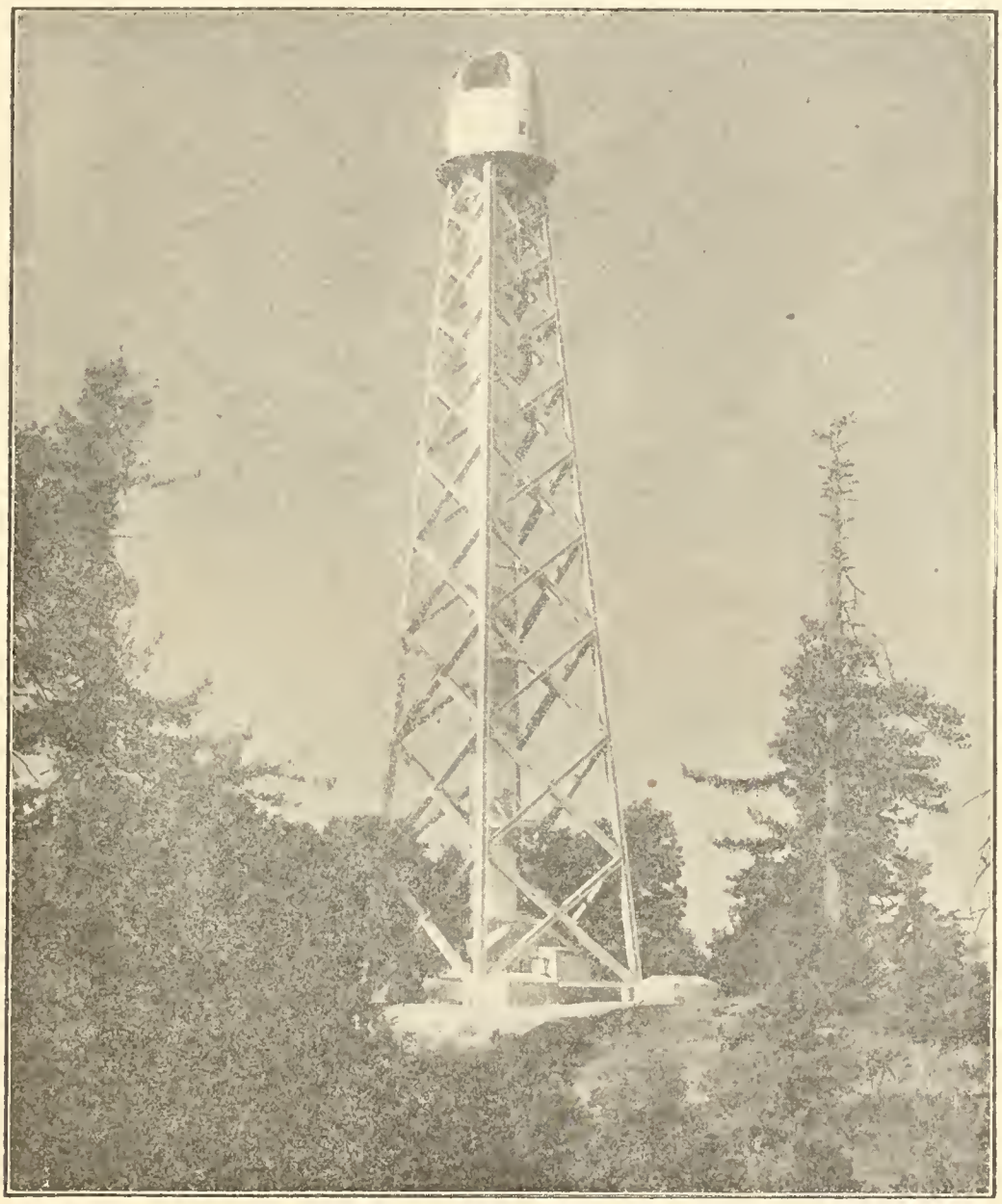
very complete. In addition to the numerous smaller pieces of apparatus there may be mentioned in particular the Snow telescope, the two tower telescopes, and the monster reflectors.

The Snow telescope consists of two 24-inch concave mirrors of different focal lengths (when either one is in use the other is easily put out of the way) mounted well above the ground in such a way as to throw the sun's rays horizontally under a louvre covering to the spectroscope or other apparatus, where they are analyzed. Soon after this instrument was in operation Dr. Hale conceived the idea of mounting the cœlostat at the top of a tower, and sending the rays vertically downward to the spectroscope so as "to avoid disturbance of definition caused by heated currents of air arising from the ground." He therefore had designed and erected a 65-foot tower for this purpose. This was very successful. Then desiring a greater focal length than could be obtained with this height, he had built a second tower 150 feet high. Under this tower a well was excavated to the depth of nearly 80 feet, thus providing for a possible focal length of about 230 feet. The 150-foot tower is of ingenious construction. It is a tower within a tower. The main structure which supports the cœlostat at the top is completely sheathed in an encasing tower which supports the dome, so that there is complete protection from the wind. When one looks at the tower he sees only the framework of the sheathing. This great tower telescope is a most efficient and satisfactory instrument.

There is no larger telescope in operation to-day than the 60-inch reflector, the reflecting surface of which was ground by Mr. Ritchey in the shop at Pasadena. The remarkable photographs of nebulæ that have been made with it speak loudly in praise of its efficiency. This instrument is soon to be supplanted in its proud position of size by the 100-inch reflector, the gift of Mr. J. D. Hooker, which is nearing completion. The figuring of the enormous block of glass has also been done by Mr. Ritchey. The present state of the building to hold this great reflector is shown in the accompanying picture. The completion of this, the largest telescope in the world, will undoubtedly mark an epoch in observational astronomy. Its light-gathering power will be nearly three times as great as that of the 60-inch, and more than seven times that of the Crossley reflector of the Lick Observatory which in its turn fifteen years ago marked an epoch. If "half a million nebulæ await discovery" with the Crossley, think of the possibilities awaiting this giant!

In the ten years of its existence the results of the investigations of the Mount Wilson Solar Observatory have been very numerous and most valuable. I have not space here even to enumerate them. Every annual report of the director contains a summary of the principal results of the year. The number of such results is noticed to increase from year to year. In the last Annual Report (1913) seventy-two results are summarized. Most of these are of such a technical nature that they are

of interest only to the scientist. Of the results of general interest I may mention the discovery of magnetic fields in sunspots; the fact that "the sun is a magnet, with magnetic poles at or near the poles of rotation"; "the polarity of the sun corresponds with that of the earth—a conclusion which may prove to have an important bearing on theories of terrestrial magnetism"; "the evidence that has been amassed in sup-

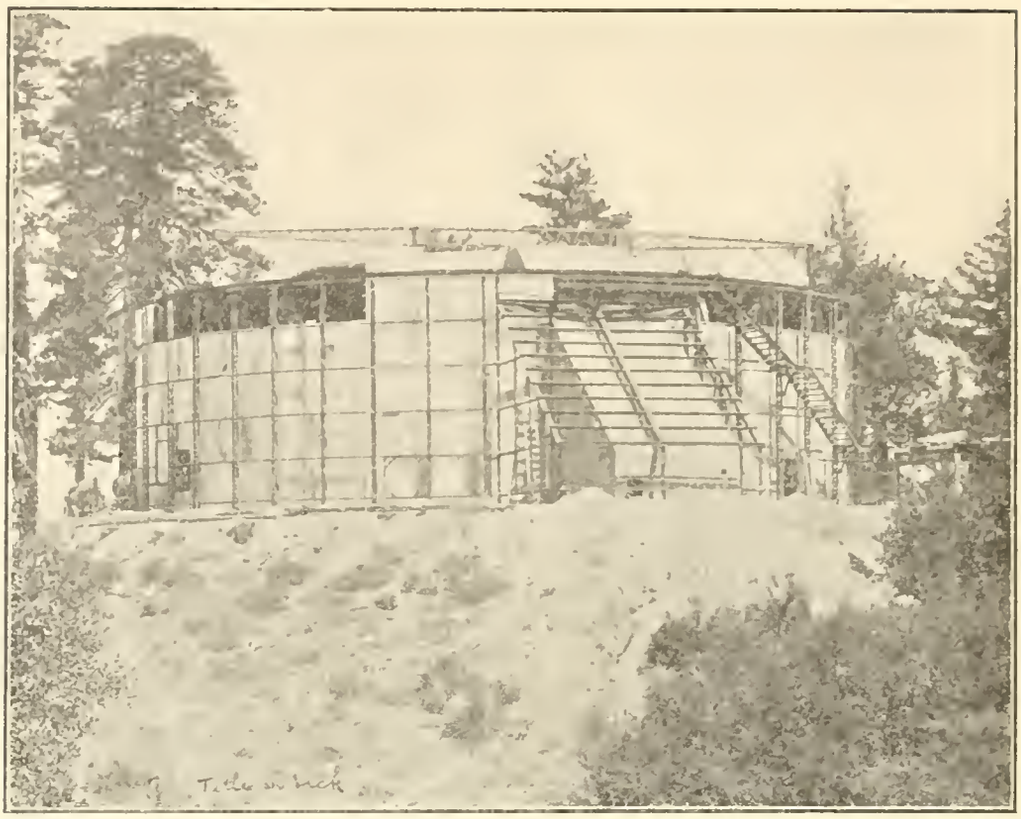


The 150-foot Tower, Mt. Wilson Solar Observatory.

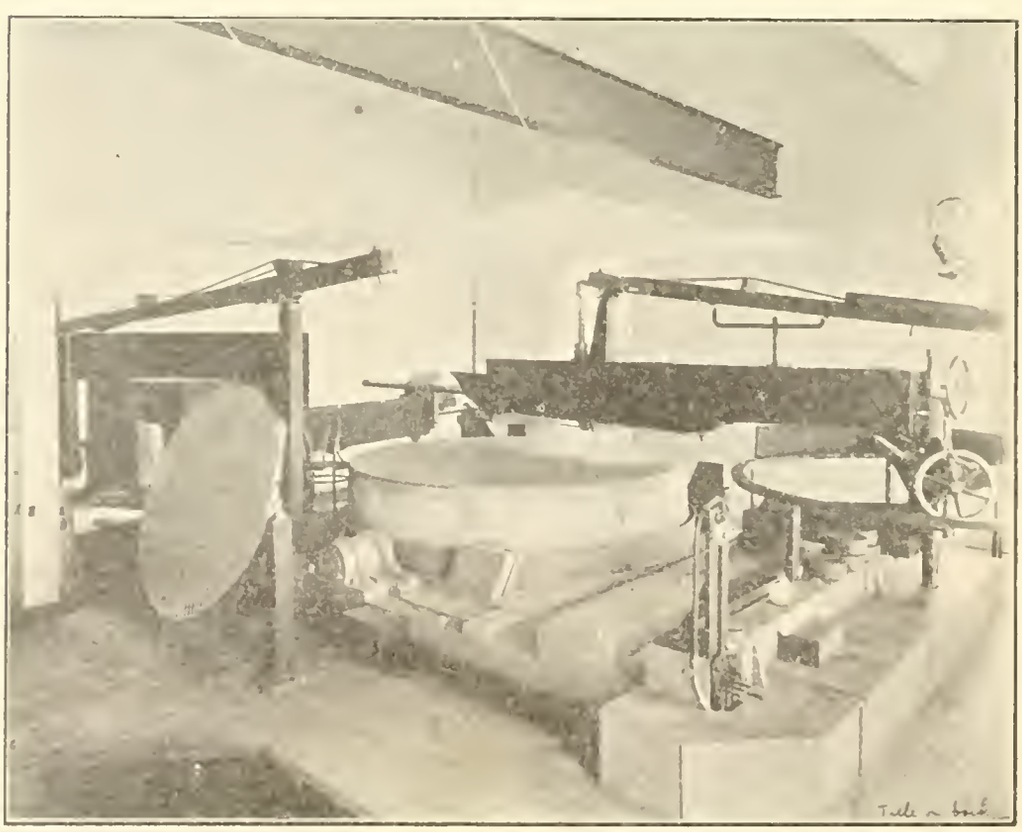
port of the view that light is absorbed in space." The last, as Dr. Hale points out

> not only offers an explanation of otherwise obscure phenomena, but promises to give what appears to be the only possible method of measuring the most profound depths of the universe.

The investigations of the solar observatory are carried on not only by the regular staff, but also by other scientists who are invited to make use of the wonderful equipment there.



PRESENT STATE OF BUILDING FOR HOUSING THE 100-INCH REFLECTOR, MOUNT WILSON SOLAR OBSERVATORY.



THE GLASS DISC FOR THE 100-INCH MIRROR, in the Pasadena Laboratory of the Mount Wilson Solar Observatory.

The Lick and the Mount Wilson Solar Observatories are the only ones at present on the Pacific coast whose energies are devoted wholly to investigations. A third will soon be in operation. This is to be an observatory eight miles north of Victoria, B. C., to house the 72-inch reflector of the Canadian government. Dr. Plaskett says:

> Word has been received from Paris that the disc for the mirror is ready for shipment and there is every prospect of the telescope being ready for erection next year.

This was written in June, 1914. A later report tells us that the disc has been received at Allegheny, and that work upon the mirror has been begun. When completed this will be the second largest reflector in the world.

In addition to these there are on the Pacific coast several small observatories connected with educational institutions whose principal use is to supplement by practical work the instruction in astronomy in these institutions. Among these may be mentioned the observatories of Pomona College, of Santa Clara College, Chabot Observatory of the Oakland High School (the Chabot Observatory is soon to be supplied with a 20-inch refractor), University of Washington, and the Students' Observatory of the University of California. Besides these there is a small government observatory, a branch of the U. S. Naval Observatory, located at the naval station on Mare Island, used principally for time service and the regulation of the chronometers of the ships of the Navy. Finally, there are a few small private observatories wherein some amateur astronomers delight to "follow the courses of the stars."

Theoretical as well as practical astronomy is well fostered on the Pacific coast. Its chief development is to be found in the Berkeley Astronomical Department of the University of California. Here has been organized a thorough school of astronomy, than which, according to the late Professor Simon Newcomb, there is none better. Not only is the science taught at Berkeley, but also theoretical investigations are continually being carried on.

It is only natural that in a region possessed of such institutions as I have mentioned there should be a considerable interest in astronomy among the people. This interest is manifested principally through an organization known as the Astronomical Society of the Pacific with headquarters in San Francisco. This society resulted from the interest taken by a group of amateur astronomers and photographers in the total eclipse of the sun visible in California, January 1, 1889. It has a membership of several hundred who are interested in a general way in the science of astronomy. In addition to its meetings the Society issues bi-monthly its Publications of the Astronomical Society of the Pacific. The Society has been given two funds the interest from which is to be devoted to giving certain medals. One of these is known as the

Donohue Comet Medal. One such medal is awarded to every discoverer of a new comet. The other is the Bruce Gold Medal, and is looked upon as one of the most important medals that can be awarded to an astronomer. It is awarded "for distinguished services to astronomy." The medal itself is a beautiful work of art, and is valuable both intrinsically and for what it symbolizes. The great value that astronomers attribute to this medal can be appreciated better when the manner of making the award is understood. The process is as follows: The directors of six observatories (Harvard, Yerkes, Lick, Berlin, Paris, and Greenwich) are each requested to nominate three men worthy to receive the medal in any given year. After these nominations are in it is usually found that six or seven names are presented to the directors of the Society from which then their choice for the medal *must* be made. If an award is made, therefore, it is to some one nominated by one or more (usually more) of the directors of six of the leading observatories of the world. There can be no doubt then that the recipient is justly entitled to this medal "for distinguished services to astronomy." That it is most highly prized by its recipients I quote from a typical letter of acceptance of the medal. The medallist writes, "I regard this distinction as the highest an astronomer can receive. . . ."

The results of the investigations at the Lick Observatory are issued in the Bulletins of the Lick Observatory for short articles, and in the Publications of the Lick Observatory (Volume XII. just issued) for the more extended work. Results from the Berkeley astronomical department are also issued in the Bulletins of the Lick Observatory, and one volume (VII.) of the Publications of the Lick Observatory is devoted to its investigations.

The Contributions from the Solar Observatory, Mount Wilson, California, issued by the Carnegie Institution of Washington, give to the world the results of the investigations carried on at the observatory on Mount Wilson and in the laboratories in Pasadena.

The Publications of the Astronomical Society of the Pacific I have already mentioned. The list of astronomical publications on the Pacific coast is made complete, I think, when I mention finally the Publication of the Astronomical Society of Pomona College, an interesting quarterly popular magazine issued by the astronomical students of Pomona College.

In preparing this account of astronomy on the Pacific coast I have drawn freely from "A Brief Account of the Lick Observatory" (fourth edition), and from the annual reports of the director of the Mount Wilson Solar Observatory. In conclusion I wish to express my thanks to the directors of these two observatories for their kindness in providing the illustrations.

THE BIOLOGICAL LABORATORIES OF THE PACIFIC COAST

By Professor WM. E. RITTER

THE study of marine botany and zoology has gained a foothold on the Pacific coast of the United States in the brief period during which biology has been institutionally naturalized in this part of the world, that promises well for the future.

Seaside laboratories have been established at three main centers of population: at Puget Sound, in central California, and in southern California. At the extreme north the University of Washington, in cooperation with several other institutions, has a laboratory at Friday Harbor on San Juan Island. In central California the Timothy Hopkins Laboratory on Monterey Bay, belonging to the Leland Stanford Junior University, has now been in operation for twenty-three years; and near by is the Herzstein Laboratory owned by the University of California. On the coast of southern California are the Scripps Institution for Biological Research at La Jolla, near San Diego, securely founded because permanently endowed, and in the vicinity of Los Angeles laboratories at Venice and Laguna Beach are manfully striving toward permanency. The Scripps Institution is a research department of the University of California. The laboratory at Venice is being fostered by the University of Southern California and that at Laguna Beach by Pomona College.

With this bird's-eye view of what the country's long western sea frontage presents in the way of effort to turn to intellectual account the riches of life of this part of the Pacific ocean, we may proceed to a somewhat closer look at what is being done.

A student of marine life who has considered the geography of Puget Sound even from afar, does not need to be told that it is a great, richly stocked aquarium of both animals and plants. Almost completely landlocked though sufficiently open at both ends to enable the water to flow through it with each run of tides, beset with innumerable irregular islands, and rock-shored everywhere, a piece of the sea could hardly be more ideally circumstanced for all kinds of organisms adapted to such conditions. For several decades the prodigality of life in the Sound has aroused the enthusiasm of naturalists, resident and visiting.

Credit for the first efforts to create a laboratory for making use of this wealth of life is due to Professor Trevor Kincaid, of the University of Washington. After several years of preliminary collecting and reconnoitering by Professor Kincaid and his students, Friday Harbor was selected in 1903 as, on the whole, the most favorable place for a per-

PUGET SOUND MARINE STATION, at Friday Harbor, San Juan Island, Washington.

manent laboratory. This salmon-cannery hamlet of a few hundred people situated on the eastern side of the large, partly agricultural San Juan island, is distant from Seattle about four or five hours' run for the small steamers which constitute the transportation system of the islands of the Sound. That the natural conditions of this location are good for the kind of work which the laboratory aims to do, there can be no doubt. The distance from the mainland ports is something of an inconvenience, but the isolation would seem to be a perpetual security against contamination of the water by a large city and much shipping; and this is a consideration of great importance for such a laboratory.

For a number of years the station went through the experience familiar to such undertakings, that of playing cuckoo so far as housing is concerned. In this instance the alien home was an abandoned salmon cannery.

But the persistence and enthusiasm of Professor Kincaid and his colleagues finally bore fruit to the extent of a four-acre piece of land, the gift of Captain Newhall, of Friday Harbor, as a permanent site; a new laboratory building about seventy-five by thirty feet in floor area, two stories high: a mess house about forty feet square; and forty-five platform tents for living quarters. The buildings were provided by the University of Washington on money appropriated by the state legislature. The laboratory proper situated at the very water's edge, indeed, partly over the water on piles, is at the foot of a beautiful wooded bank that reaches up one hundred feet or more at an angle of full forty-five degrees from the back door of the building. The first floor of the laboratory is mostly one large room in which are the salt-water aquaria and facilities for experimental work of various sorts. On the second floor are nine private workrooms and a large room thirty

feet by thirty feet which is used for various laboratory and other purposes. Besides the work space in the laboratory building a laboratory for botanical study has been fitted up in the basement of the commons building.

The station owns a fleet of a dozen row boats, but as yet no power boat, dependence been placed so far on hired boats for the heavier bottom collecting.

This station stands alone among its kind on the Pacific coast in aiming to be intercollegiate in constitution and maintenance. While, as already indicated, the "plant" has been furnished by the state, and is owned by the university; and while the state is at present supplying nearly all the maintenance funds, about $3,000 a year, a system of cooperating institutions is nevertheless being worked out. At present the Universities of Kansas and Oregon and the Washington State Normal School at Billingham are, I believe, the only institutions in the partnership, but the plan is being earnestly pushed and other schools and colleges, notably Reed College of Portland, Oregon, seem likely to enter.

So far the laboratory has not aimed at much beyond formal instruction and general information-getting on the part of those who assemble there; and sessions have been restricted to a few weeks in the summer. The session of 1913 saw an attendance of about one hundred teachers and students, these being drawn from a wide area of the northwestern United States. This considerable number may be taken to indicate the reality of the demand for opportunity for this kind of study in this region. No doubt this demand will increase and will soon expand to include advanced specialized studies and genuine investigation as well as elementary instruction and general information. Since the beginning of the session of 1914 Professor T. C. Frye, of the department of botany of the University of Washington, has been director of the station, Professor Kincaid having turned his interest and efforts in other directions.

Traveling down the coast from Puget Sound to central California, one finds the Timothy Hopkins laboratory at Pacific Grove on Monterey Bay belonging to the Leland Stanford Junior University. This is the pioneer among the marine laboratories on the Pacific coast, its life being practically coexistent with that of the university of which it is a part. It began its work in 1892, only about a year after the university opened its doors. It is also the most commodiously housed of the western stations, and, in keeping with its greater age and size, has furnished facilities to more biologists than any of the other Pacific coast laboratories.

About eighty students can be accommodated in the station's two buildings. There are four general laboratories, one lecture room, and

seventeen private laboratories for investigators. The buildings, of wood, are both two stories high, well lighted and amply supplied with running water, both salt and fresh. According to the directors, about seventy-five investigators have made use of the laboratory since its foundation and something like six hundred and fifty students of various grades have received instruction. Regular class instruction is given each summer by university professors from the departments of zoology, botany and physiology. Although the buildings are not formally open during the rest of the year, investigators are usually able by special arrangement to get the use of the laboratories at almost any time.

The laboratory was a gift of Timothy Hopkins, of Menlo Park, Calif., but is dependent on the university for maintenance funds, library, and equipment. Students who receive class instruction pay fees, the money derived from this source being applied to the running expenses of the institution.

Professors C. H. Gilbert and O. P. Jenkins, of the departments of zoology and physiology, respectively, have been from the beginning joint directors of the laboratory, but the courses of instruction have been mostly given in later years by the younger men of the university, Professors Harold Heath, F. M. McFarland and W. B. Price having been especially faithful and efficient in this capacity.

Pacific Grove is an exceedingly advantageous location for a marine station, particularly one with the aims which the Hopkins laboratory set for itself; namely, those of providing facilities for investigations on littoral animals and plants and those inhabiting the bottom in relatively shallow waters; and of giving instruction to elementary students.

So far as the writer's somewhat extensive observations on the Pacific littoral of North America has gone, no other point on the whole coast, with the possible exception of Yakutat Bay in southeastern Alaska, has a rocky shore fauna and flora of greater luxuriance, whether as to individuals or species, than has the southern shore of Monterey Bay. This richness of life, taken along with the accessibility of the locality from a populous center, and the all-year-round congeniality of the climate, has made the Hopkins laboratory an important factor in the promotion of biological science in this part of the country. It is greatly to be hoped that at no distant day the laboratory will become possessed of sufficient funds to enable it to be fully prepared to receive investigators and students at any time of the year, and not be obliged to restrict its activities so largely to the summer months.

The Herzstein laboratory, also at Pacific Grove, is quite different in aim and scope of activities from the Hopkins. It was a gift to the department of physiology of the University of California by Dr. Morris Herzstein, of San Francisco, the primary purpose of which was to provide a sea-side working place where Professor Jacques Loeb could prosecute certain of his investigations.

In keeping with the relatively simple technic of the studies which have made this biologist famous, the Herzstein laboratory is small and inexpensive. It is a plain, one-story wooden building, about forty-five feet square, divided into three fairly good-sized rooms, two small store rooms and a dark room. It is provided with an alternating electric current, and running fresh water, but not with gas or salt water. The small quantities of sea water needed are brought to the laboratory from the nearby sea by hand. A good supply of glassware for experimentation on simple animals is always on hand.

As already indicated, the laboratory is operated in close connection, so far as research is concerned, with the department of physiology at Berkeley. No provision is made or is hardly possible for formal instruction or for any considerable number of investigators, or for much range of investigation.

At present Professor S. S. Maxwell, as head of the department of physiology, also has charge of the laboratory. Professor Loeb's use of it has not ceased, although he has severed his connection with the University of California. He has spent considerable time at Pacific Grove during the last two years.

Going on down the coast to southern California, the undertakings at Venice and Laguna Beach must first be noticed in following the geographical order of treatment. Although, as intimated in the opening paragraph, these have not attained a strong and permanent existence, they have been useful as adjuncts to the teaching facilities of the colleges to which they belong, the University of Southern California, and Pomona College. The Venice Station possesses a power launch of sufficient size and equipment to make possible a good amount of collecting at sea. The director of the station is Albert B. Ulrey, professor of zoology in the University of Southern California.

The suggestion may be ventured here that the California coast south of Point Conception ought to have one good teaching sea-side laboratory which should have the support of all the schools and colleges in the south. We biologists of the southwest must, I think, allow that we are aspiring less wisely than are our colleagues of the northwest in the very important matter of promoting sea-side studies by young men and women.

The Scripps Institution for Biological Research being situated at the extreme southern end of the Pacific coast line of the United States must accept last place in this survey.

A somewhat full account of this station was published by the writer in 1912,[1] and the accessibility of this makes an extended statement here superfluous.

[1] "The Marine Biological Station of San Diego, Its History, Present Conditions, Achievements and Aims," Univ. of Calif. Publ. in Zool., Vol. 9, No. 4, March 9, 1912, pp. 137–248.

Though privately founded and for some time without organic connection with any other institution, its property and endowment were deeded to the regents of the University of California in 1911, thus making it a department of the university.

The main elements in its physical being are 177 acres of land with a half mile of ocean front in the city of San Diego about two miles north of the suburb of La Jolla; a fireproof reinforced concrete laboratory building 47 by 74 feet, two stories high; a 20,000 gallon concrete tank for sea water with tank house; thirteen cottage residences, one of which is a commodious two-story structure; one carefully planned and well-built animal house for experimental breeding; and an eighteen-ton motor boat, the *Alexander Agassiz,* equipped for biologic and oceanographic work at sea.

The laboratory contains twelve individual research rooms, six of which are furnished with aquaria constructed of concrete, iron and plate glass. There is also a general aquarium room with concrete tanks and glass aquaria.

A room 40 by 32 feet on the second floor contains a well-displayed collection of the marine life of the San Diego region. On the first floor in a combined collection and reagent room are arranged several thousand bottles of research collections, chiefly of pelagic organisms.

The library, consisting of about 3,500 bound volumes and a much larger number of pamphlets, occupies three rooms on the second floor, one of which serves as a journal and reading room. The books are fully classified, catalogued and arranged, and as the number is increasing rapidly the library is becoming a fairly good one for the kinds of investigation prosecuted by the institution. The university library at Berkeley still has to be called on, however, for many works, particularly when studies which fall outside the program of the institution are being carried on.

At present the institution has an annual income of about $20,000, $10,500 of which come from the Scripps endowment, $7,500 from the state of California, and the balance from miscellaneous sources, chiefly rentals.

The staff consists of four resident investigators, three of whom are biologists and one an oceanographer; a business manager who acts also as master of the *Agassiz;* a scientific secretary who serves likewise as assistant librarian; an engineer and keeper for the *Agassiz;* and a helper for the buildings and grounds. In addition, there is a non-resident contingent of the research staff consisting at present of four biologists. These are able by reason of their vocations to be in La Jolla only at irregular intervals and for short periods, but are regularly engaged upon the institution's program. They receive fixed compensations for their work.

The brief statement to be here made about the policy of this institution will be facilitated and possibly rendered more interesting by putting it in the form of a trenchant comparison between the two exclusively research stations of the Pacific coast; the Herzstein laboratory at Pacific Grove and the Scripps Institution.

For full two thousand years there have been among the inquiring two conceptions or faiths about the nature of the world, particularly the living part of it, that stand over against each other with a sharpness and apparently irreconcilable antagonism which, seen in their fullness, are highly poetic as well as profoundly scientific. These two conceptions flow from the university experience of the unity, on the one hand, and the diversity, on the other, of nature. Because of the first some men have conceived that at its core nature is One and Simple; and with an irresistible faith they have sought to penetrate to the single essence or substance held by this philosopher to be Spirit, by that Matter, the grasping of which should constitute the discovery of the great mystery of existence.

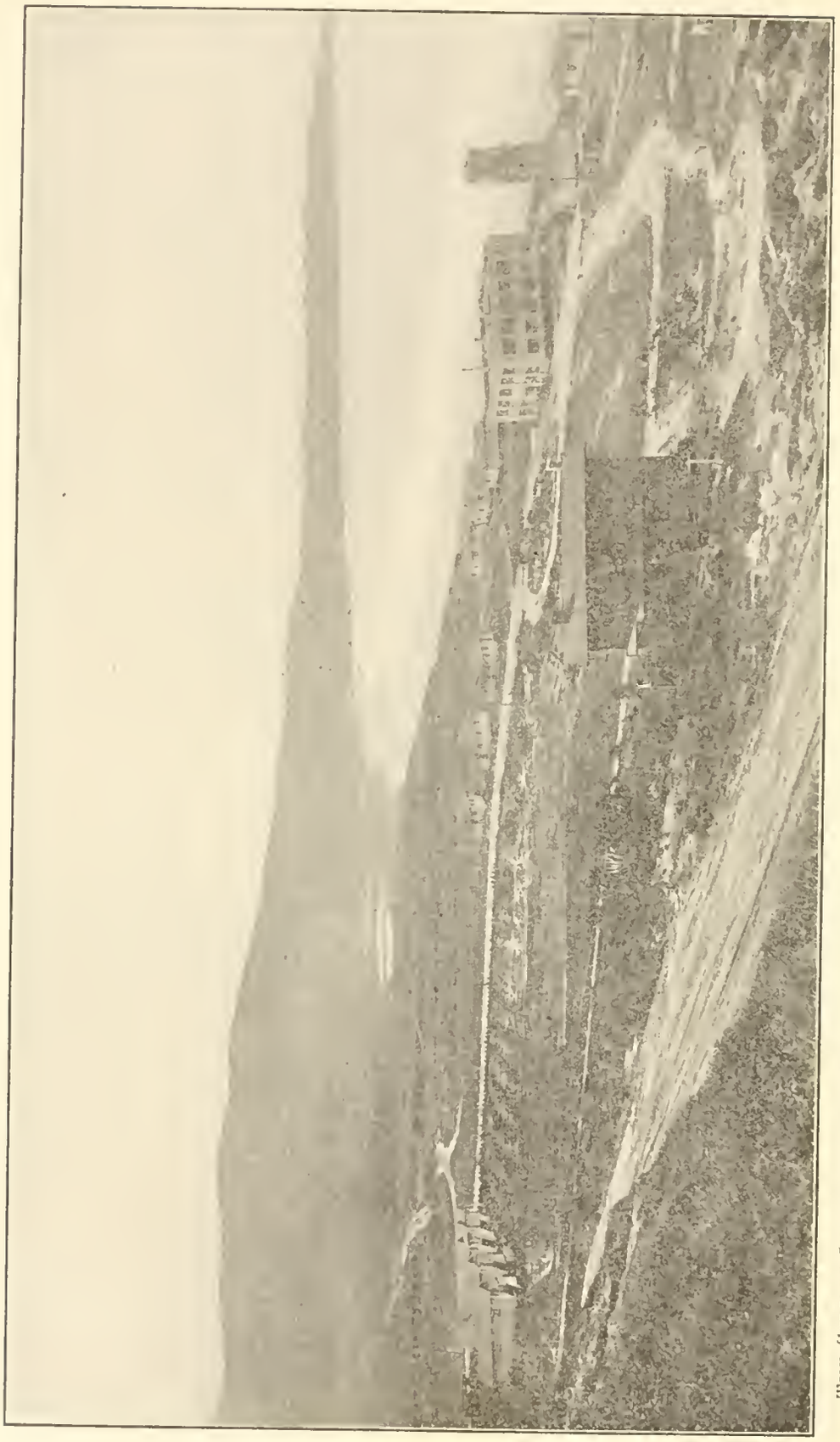
This kind of faith has found no finer expression in the modern era of all-pervading scientific analysis than in Tennyson's

> Flower in the crannied wall,
> I pluck you out of the crannies;—
> Hold you here, root and all, in my hand,
> Little flower—but if I could understand
> What you are, root and all, and all in all
> I should know what God and man is.

The distinguished scientist whose investigations the Herzstein laboratory was built primarily to further would probably agree that were his ultimate biological ideas and aims to be expressed in the poet's way, these lines would need as little alteration as any that could be found. He might wish to have the first line so altered as to give the flower's place to the sea urchin; and would probably want "God" replaced by "Mechanism" or some term which disguises its anthropomorphism as effectually. But the great basal idea ". . . if I could understand What you are . . . all in all, I should know what God and man is," would presumably need no alteration.

And why should not devout chemico-physical biologist and devout theist alike have each his unfaltering faith in substance, One or at most very few, All-pervasive, All-potent, Eternal? For has not each in his own sphere and his own way discovered to the deepest depths of his nature a few mighty realities underneath the vast, bewildering maze of phenomena?

No one can look upon the simple laboratory under the pine trees at Pacific Grove and contemplate the idea for which it stands without seeing true grandeur in its simplicity.



THE SCRIPPS INSTITUTION FOR BIOLOGICAL RESEARCH, at La Jolla, California; looking southwest across Long Beach to La Jolla.

But is the oneness of the world with its demonstrably underlying few substances and forces, whether these be held to be material or spiritual, more real than the diversity of it? Surely it is not so far as the every-day lives of every-day people are concerned. And the view that science is common sense refined and systematized withstands all objection. The fisherman's Albacore endures whatever test of reality may be applied to the biologist's sea urchin eggs or anything contained in them. It is impossible to define any given specimen of living substance so as to ascribe to it ultimateness without ascribing ultimateness to the living animal itself to which the specimen pertains if the same rules of defining be adhered to throughout. But if every part of the living world is as real and as ultimate as any other part, it is futile to expect to fully understand some portions of it by knowing other portions of it. The theory that any amount of understanding, even complete understanding, of a flower or a sea urchin would give complete understanding of man, to say nothing of God, is contrary to the fundamental nature of things and of knowledge. Nor, speaking chemico-physically, can any amount of understanding of the substances of which an organism is composed give complete understanding of the organism itself.

Vastly contributory to the understanding of organic beings as are chemico-physical investigations upon them, indeed impossible though it is to gain exhaustive knowledge of them in any aspect of their lives without such investigations, every truly vital chemico-physical problem of organisms is two phased: how do the chemico-physical attributes of the constituent substances act upon and so explain the organisms; and what particular structures and activities are the chemical substances caused to manifest by being constituents of and used by the particular organisms?

And so it is revealed that the familiar dictum "all life is one" must not be understood to mean that living nature has *only one life;* but rather that there is some thing *in common* among all the myriad things that live, namely, the half dozen, less or more, chemical simples now known to compose a living being. The diversities of living nature are, consequently, as "ultimate problems" as are its uniformities; and the biological institution which should set for its goal final solution of the problems of the organic world would be vast and complex and costly beyond any thing yet created or likely to be.

The administrative body of a research foundation in biology which should so understand biology would always have before it this compound question: what particular subject or group of related subjects at this particular time, in this particular locality, and under existing limitations of resources would best be investigated?

The Scripps Institution conceives its purposes in this way, at least while its present director stands as spokesman of its purposes. Just

now its small resources are being devoted to certain aspects of the mode of life of organisms in nature; to the nature and relationships of natural races; and to the influence of natural environments upon organisms, particularly as to the heritability of such influences. No other subjects are, in the belief of the management, of greater moment to present-day biology, and various circumstances make their study by the institution peculiarly practicable. But the managing board have no delusions as to the uniquely "burning" character of the questions under investigation, or as to its having reached the threshold of the Ultimate Mystery of Life and Death. Its profound belief in the importance of biologic truth to the welfare of humankind is of such sort that it knows that many other problems being studied by many other men and other institutions are no less vital than those engaging its efforts; and that problems of to-morrow, next year, next decade, next century, while different from those of to-day, will be no less numerous and no less insistent than those of to-day. It holds every item of positive knowledge of the living world essential to the scientific interpretation of that world; that such interpretation alone can beget a right attitude toward that world; and that the high level of man's development which we call civilization is wholly dependent upon a right attitude on the part of the largest number possible of the community toward all things that live.

THE LAST WILD TRIBE OF CALIFORNIA

By Professor T. T. WATERMAN

IN the fall of 1908 some attention was aroused in the press by a story to the effect that hunters had encountered in the state of California a tribe of Indians who were still in the stone age. The idea of a "wild" tribe in a thickly settled region like California was so novel that it served to awaken a very wide interest. The Indians themselves, however, had meanwhile vanished. Some three years later an individual who had all the appearance of belonging to this group was apprehended in northern California. He was put in jail, and a few days later turned over to the university. Since then he has been received everywhere as the last survivor of his tribe. The whole series of incidents deserves some explanation. I think it ought to be said at the outset that the story as given in the papers of that period is quite true. The individual captured in 1911 was a surviving member of a stone-age tribe. He is still alive and well at the university; and he has given from time to time extremely interesting accounts of the history of his people.

I should like to explain first of all the rather unusual career of this tribe, and how they happened to remain "wild." The occupation of California by the whites is usually pictured as a peaceful transaction. We hear little of Indian wars in connection with this state. The California tribes pursued, as it happened, a more or less settled mode of life. Being non-migratory, they were peculiarly open to attack and reprisal for any resistance they could have offered to the white invasion. The influx of whites moreover was on the whole so sudden and overwhelming that those Indian disturbances which did occur were soon forgotten. It is quite possible that if California had been settled one family at a time as New England was, "massacres" and "wars" would have occurred that would have rung down the ages like the wars waged by the Indians on the Colonies. If there had been a long course of conflicts, our California tribes might have developed a name for ferocity like that enjoyed by the Mohawk, or the Apache. As a matter of fact, the white occupation here was accomplished by violence and bloodshed, and through armed conflict with the natives far and wide. The U. S. Army records show almost as many movements of troops against the Indians as occurred in any other area of the same extent. The whole period of "occupation" was so short, however, that Indian troubles for the most part were soon things of the past.

So much for the general situation in California. In the wild and rugged part of the state, Indian resistance lasted for a long time. One such area was west of the Sacramento in the Siskiyou region, along the upper waters of the Trinity and Eel rivers. "Bad" Indians used to frequent the wilds in this part of the state long after the tribal organizations had broken down. Such Indians caused some little trouble to enterprising settlers in the hills. A region where the Indian opposition was still more spirited and where Indian disturbances dragged out still longer was in northeastern California. Here the Pitt River Indians, and later the Modocs, put up a number of very spirited contests before knuckling under. The whites, on the whole, were very bitter towards "wild" Indians, even when harmless, and blamed them for everything, from the occurrence of freshets to the presence of potato-bugs.

It must of course be recognized that the occupation of California by the whites was inevitable. The Indians had to be dispossessed to make room for the new order. The white occupation, however, was not only inevitable, it was relentless. The methods used are not a thing of which we can be proud. The whites, for example, introduced into California, where it was unknown prior to their coming, the practise of scalping. It was very much the fashion in the early days for white settlers and miners to carry on Indian wars individually and informally. The line between their actions and plain murder is rather hard to draw. Many of the white loafers and irresponsibles that "bummed" around the frontier settlements used to preach openly a doctrine of "exterminating" the Indians. A very considerable proportion of our "Indian fighters" in this state deserved, in strict justice, to be hung. It may throw some light in general on the nature and methods of these "wars" to state that there existed in California, long after the close of the civil war, a lively traffic in Indian slaves. White administration of Indian affairs in the more easterly states impresses one most by its hopeless stupidity. The history of whites and Indians in California impresses one rather with a sense of the white man's ruthlessness.

The Yahi Tribe

In the northeastern part of the Sacramento valley there lived a nation of Indians who were early driven into a vigorous hostility to the whites. They had already, from their friction with other tribes, developed some adeptness in raiding and thieving, and in a sort of guerilla warfare. Their northern branch, the so-called Nozi, after a time capitulated, and became hangers-on of civilization. The southern branch of the stock, calling themselves simply Yahi, or "people," and inhabiting a stretch of country immediately east of the Sacramento, kept the whites in a state of uncertainty for a considerably longer time.

There is one relatively small region in particular which came to be specially identified with this small group of Indians. That is the country immediately about Mill Creek. East of the Sacramento, along the waters of Antelope Creek, Mill Creek, Dry Creek, Deer Creek and Butte Creek, the country is covered with a cap of lava. The original source of this lava was, I believe, the mountain which has recently been attracting so much attention to itself—Lassen Butte. The elevation of the region frequented by hostile Indians is not great (it all lies below the level of the pine forest) but the streams have cut in the lava a large number of rough cañons and gullies. Near as it is to the level valley, the country is extremely rugged. Cliffs, crags, and sudden promontories are frequent, and there are great numbers of caves. While the settlement and cultivation of the valley has gone forward very rapidly, this region in the foothills has remained almost untouched. To-day this "lava" country is the resort of animals (and to a certain extent, of plants) which are becoming extinct elsewhere. In this small region in north central California the Yahi made a determined stand against civilization.

In the course of their life in these cañons they developed an intense hatred and fear of the whites. They came to be hunted very much like wild animals. Accordingly they developed peculiar habits of visiting the valley in sudden forays, escaping instantly to the hills afterwards. These sudden visitations, often resulting in the loss of life as well as property, were a genuine bugbear to homesteaders. On the other hand, the Indians were on their part often harried by famine. Pressure from the whites prevented them from making full use of the natural foods the country afforded. Even acorn-gathering was for them a dangerous pursuit, since it gave opportunity for white attack. Their natural means of subsistence therefore seem to have been almost entirely cut off. An idea of their desperation may be gathered from the fact that on at least one occasion when they attacked the whites and were chased, their plunder consisted of a mule-load of vegetables. In other words, they took the field and risked their lives for the sake of a few squashes and some ears of corn.

It has always been supposed that remnants of several tribes made up these Mill Creek renegades. From what we have recently learned, it seems very unlikely that there was more than one tribe involved. In the first place, the only member of this hostile group who has ever been questioned, expresses the liveliest dislike of all other tribes. He seems, and always has seemed, more ready to make friends with the whites themselves, than with the neighboring groups of Indians. In the second place, all the other Indian tribes of the region profess the liveliest horror of the Yahi. This awe extends even to the country to-day which the Yahi frequented. Even the Yahi and the Nozi, though they spoke

dialects of one language (the so-called Yana) express the most unrelenting hostility for each other. In other words, the Indians who lurked about in the Mill Creek hills for several decades after the settlement of the valley, were probably the remnant of a comparatively pure group, since there was little likelihood of intermixture.

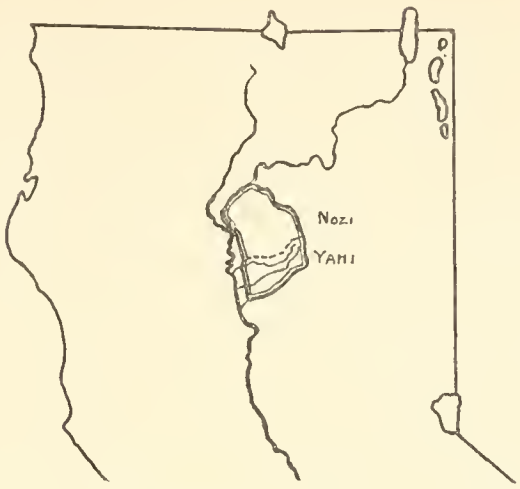
The Mill Creek "War"

Between the years 1850 and 1865 this group was more or less under observation by the government. Rumors of battle, murder and sudden death came frequently from this region to the central authorities in San Francisco and Sacramento. On one or two occasions attempts were made by the War Department to apply the universal remedy for Indian troubles—removal to a reservation. Details concerning the movement of troops and some very heated correspondence relative to this tribe may be found in the government records (War Records, Volume 50). The names of some very distinguished Californians appear in this connection. I recall especially Governor Stanford, and General Albert Sydney Johnston. The only book I know of which deals exclusively with events in the Yahi region is a small but vivid volume written by R. A. Anderson, an actor in the events, and sometime sheriff of Butte County ("Fighting the Mill Creeks," Chico, Cal., 1909). This little work checks up with the records of the War Department. The "war" with this small tribe seems to be quite overlooked in the histories of California. There is no mention of it in either Bancroft or Hittell. The reason probably is that it was very much like what had happened, or was happening, on a larger scale elsewhere. The War Department correspondence is quite full for the period covered.

The end of the Mill Creek "war" was unusual and to some extent tragic. A party of armed whites, acting without other authority than resentment and an inborn savagery, surprised the tribe on the upper waters of Mill Creek in 1865. Their effort apparently was to wipe out this Indian group on the spot. On the admission of men who took part in the action, fire was opened on the defenceless Indians in the early morning, and an uncertain number of them, men, women and children, shot down. A few, not more than three or four, perhaps, escaped into the brush and got clear. The Mill Creek tribe as a tribe disappeared from history at this time. With one or two possible exceptions, nothing was seen of it again for over thirty-five years.

Hidden Life of the Survivors

The survivors who escaped these executive measures of 1865 were too few in number to resume their old mode of life. They were, on the other hand, so small a party that they succeeded in hiding away. Little by little they emerged from their hiding places and took up again the



MAP OF NORTHERN CALIFORNIA showing the location of the Yahi and Nozi peoples.

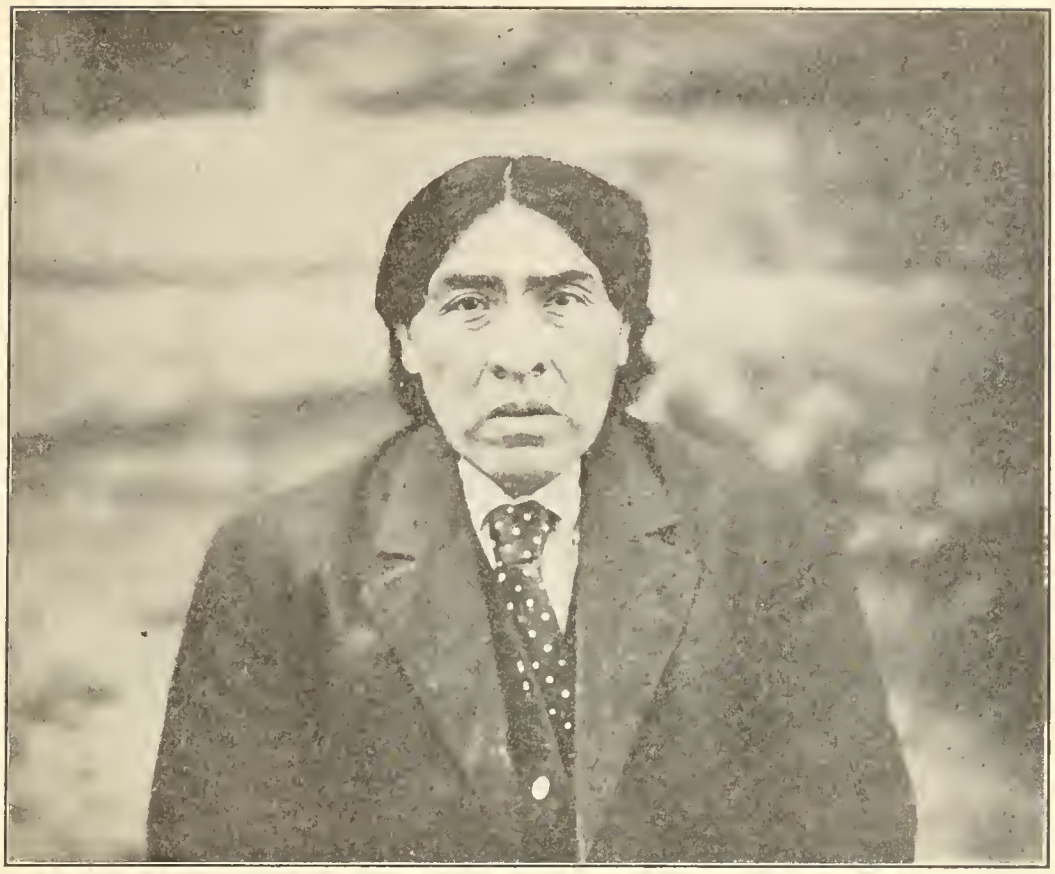
procuring of food by hunting and fishing. They did not, however, allow themselves to be seen. They undoubtedly expected annihilation to follow on discovery, and probably there was sound judgment behind this belief. The almost entire absence of information concerning them proves that they took to the wildest places, and stayed there. All that we positively know about them is that they disappeared in 1865, but were still alive in 1908. Under the circumstances, they must have remained "primitive." Only the primitive mode of life was open to them. They were primitive when they went into retirement, and it was their salvation. When seen again in 1908 they still used the bow and arrow and other aboriginal appliances, and were absolutely unfamiliar with the usages of civilization. Their avoidance of observation of any kind left them as isolated as if they had been literally on another continent.

Our information concerning them during this period is very scanty.

DEER CREEK CANON. The last refuge of the "Yahi" tribe.

The existence of "wild" Indians in this part of the world was known, or at least believed in, in many quarters, in spite of definite information. Thus Stephen Powers in his classical "Tribes of California" (U. S. Department of the Interior, Contributions to North American Ethnology, Vol. 3) says, without giving names, that five of this tribe, two men, two women, and a boy, were seen in 1870. This group gave from time to time further proof of their existence by their habit of secretly taking food from distant and lonely mountain cabins. It is a settled fact, that this fugitive remnant of a tribe did fairly well with their primitive mode of life, except in the late winter and early spring. By that time their stores were usually exhausted and the salmon had not yet begun to run in the streams. Their fear of the whites forbade any change of home or habitation in search of food. The only course possible, aside from quiet starvation, was to seek out some white man's cabin somewhere in the hills, help themselves to food as quickly as possible, and carry it back to their lurking places. This they seem to have done on several occasions almost every year. To this we probably owe the fact that the group managed to remain alive. This robbing of cabins could not, of course, pass unnoticed. Such cabins as exist in these hills are mere temporary shelters, utilized by wandering hunters and stockmen. Any passer-by, according to the custom of the country, is at liberty to invite himself into a cabin if he happens to find one that is in use at all, and is supposed to give himself full rights and privileges, including the use of all solids and liquids. This is a sort of informal hospitality which prevails universally. The Indians, when compelled to risk dis-

ISHI, THE LAST OF THE YAHI. From a photograph taken after his capture at Oroville, California in 1911. He is wearing a "slaughter-house apron" put on him before he was taken to town. His hair he had burned off with a firebrand, as a sign of mourning, throwing on water with his hands to keep from burning his scalp. The remaining photographs in this article were taken recently, after his appearance was much changed.



ISHI AT THE PRESENT TIME.

covery in visiting a cabin, took as much food as they possibly could, to lessen the chances of having to make another trip, and ran away. They usually made a systematic collection of everything eatable, down to the last scrap, and carried it off. While the mountaineer has liberal notions of hospitality, they do not extend to this. The visits of the Indians were bitterly resented. They left their unwilling host in most cases, on his return, no resource but to walk back to civilization, empty within and without.

Such food-gathering expeditions were conducted with true Indian slyness. In spite of the fact that such "robberies" were fairly frequent, and extended over a period of thirty years, the Indians were never seen. Not only that, but no one ever found so much as a track or footprint. Often the only trace the Indians left of their presence was a total disappearance of everything edible. On one occasion a white mother returned to her homestead from berry-picking with two small children, to find nothing in her larder but two cold boiled potatoes. On another occasion, two mountaineers, who left in their camp two months' provisions, found on their return only part of a sack of barley. On other occasions the Indians took from camps even the barley that was intended for horse feed. Many of these robberies might have been blamed to white men, except for the fact that stuff was taken which a white man would not bother with; for example, the barley just mentioned. While useless to a white, it was readily usable by starving Indians who were accustomed to making food out of acorns and grass

WATCHING FOR SALMON.

seeds, and had at hand their primitive devices for milling such things. On the other hand, the small quantities of canned stuff found in the cabins and camps were never touched. The Indians seemed to have a peculiar fear of it, perhaps from one or two unfortunate experiences, with canned goods that had spoiled. On at least one occasion there was taken from a cabin a small quantity of flour conspicuously labelled *poisoned*. No white man would have taken chances with this flour, however hungry.

More than once on such expeditions the Indians were perilously near exposure. Once an excited white man, with a repeating rifle and dogs, trailed them so closely that in crossing a stream they dropped a piece of headgear in their hurry. This headdress, fearfully and wonderfully wrought out of scraps of a dozen different fabrics, is now in our Museum. At the time of this escape the Indians were not seen, though where they had forded the stream the rocks were still wet.

Mere chance on several occasions nearly resulted in discovery for them. A hunter one time, passing along in the winter, noticed a low smoke rising out of a snow-covered thicket across a stream where he knew that no white man would have been. Later on, after the final emergence of the tribe from their obscurity, we found the remains of one of their encampments in this very thicket.

Such is the only actual evidence we have of the life of this tribe for over a generation. The most important change within that period is a shift in their habitat. After the massacre of '65 they lived at various places up and down the stream known as Mill Creek, robbing cabins when driven by famine. After 1885 however no more cabins were robbed along this stream. The Indians were evidently driven out by the in-

creasing degree of settlement. The next stream to the south is known as Deer Creek. The gorge through which this stream passes is rugged and wild in the extreme. It is in fact one of the most picturesque cañons in California. The wildest part of the cañon of Deer Creek was their last home.

Below the mouth of a side branch known as Sulphur Creek, the cliffs which hem in the main stream open out into a fairly wide valley. Between the base of the cliffs on the south side and the stream itself, is a long slope composed of lava detritus. This slope consists of rocks piled up in tremendous confusion, traversed with deep gullies, and overgrown with a perfect mat of scrub oak. The brush is so thick that it is practically impenetrable. Even sheep and cattle avoid the place. I doubt if such animals could make their way through it. Two or three miles through this thicket is a good day's work for a man. Here the Yahi tribe, or its remnant, found a final refuge. In one edge of this jungle, on a shoulder overlooking the stream, under some pepperwoods or laurel, they built some tiny lodges. To this locality and little village they gave the name of Bear's Hiding Place. The mountains and plateaus hereabout are useless for cultivation. The lava cliffs contain no metals. The country is quite unfrequented except for cattlemen and cowboys, who come at certain times of the year and "round up" their stock. Since the live stock never penetrated the jungle where the Indians lived, the stockmen also avoided it. Here for over twenty years the Indians lurked in peace.

They do not seem to have lived here exclusively. As far as we can

MAKING A SALMON-SPEAR. Two foreshafts, which are to carry toggles, are being fastened in place with cord.

gather at the present time, they ranged in the summer as far east as Mount Lassen. On the upper slopes of this tremendous peak they found plenty of game, and no one to disturb them. When it grew cold they returned to the foothills and passed the winter at Bear's Hiding Place. Near the lodges there is to be found a circular pit some three or four feet deep. This pit they were accustomed to pack full of snow. The melting of this snow gave them a supply of water and saved them the trouble and risk of going down to the creek, some five hundred feet below.

The village site has now been visited by a number of people, scientific and otherwise. I think they will all agree that the placing of the lodges was the work of people who were not only desperately anxious to hide themselves, but who knew thoroughly well how to do it. The houses were built where they were invisible from the cliffs on either side. The Indians passed down to the creek, which was very important to them on account of the fish in it, under the shelter of a growth of laurel. Thus they could move about and still remain hidden. Moreover, they avoided making visible trails, especially near the water. The little path that leads down from the lodges under and through the thicket, ramifies and disappears as it approaches the stream. In other words, they went down by different ways, to avoid making one conspicuous pathway. In making the needful paths through the brush, they bent aside the necessary twigs. Cutting or breaking them would have made the path much more conspicuous. I doubt if an observer on the cliff would ever have seen the Indians if he had been looking directly down upon them. Altogether, the place and its selection showed considerable evidence of craft, and to the wandering hunter or rider on the mountains round about, the locality would have looked always like a genuine bear's hiding place, for all the evndence of human habitation to be seen.

The Breaking Up of the Hidden Village

Such was the life of this group until the year 1908. At that time a party of surveyors, on engineering business, happened by mere luck to encounter them. One evening a naked savage was suddenly observed, standing on a rock by the stream side, armed with a long spear. This resulted, from all accounts, in the equal alarm of all parties. The next morning, those members of the party who had not run all the way to camp, went down to the place, cast about in the brush, and finally came upon the Indian lodges. Two Indians, running for their lives, were actually seen—one of them an old man, helped along by a middle-aged woman. This fleeting glimpse is all that we know of these individuals. They have never been seen again. Their actual fate is still unknown. In camp was found, under some blankets, a partially paralyzed old woman, frightened nearly to death, unable to move. The whites did what they could for this old person, then helped themselves, mainly in

a spirit of curiosity, to the contents of the camp—bows, arrows, skin blankets—and after prying about, went back to camp for dinner. When they returned next day the old woman was gone.

Such was the tragic end of the last remnant of the Yahi tribe. Except for one individual, our account closes here. The members of the tribe who were seen at this time seem to have perished from cold, hunger, and exposure, without ever returning to their camp.

Nearly three years later, in August, 1911, at a slaughter-house four miles from Oroville, eighty miles away, one morning there suddenly appeared from nowhere a naked Indian. His only garment was an old castoff undershirt. He was thin, hungry, greatly worn, and of most unusual appearance. The people in charge of the premises telephoned to the sheriff and reported with some excitement the presence of a "wild man." No one, Indian or white, could make him understand a word. The sheriff of Butte County came out, took the wild man in charge and gave him, as the most available lodging, the insane cell of the jail. When the news reached the university, the appearance of this strange Indian was at once connected with the Yahi tribe of Deer Creek, in which the department of anthropology had long been interested. It fell to the lot of the present writer to journey to Oroville to identify him. Our only resource was to "try him out" with a vocabulary in the Nozi dialect, since there was no material in existence in what was thought to be his own proper language. The first impression received of the wild Indian was the sight of him, draped in a canvas apron they had hurriedly put on him at the slaughter-house, sitting on the edge of a cot in his cell, still uncertain of his fate, and answering *ulisi* ("[I don't] understand") to all the questions that were being fired at him in English, Spanish, and half a dozen Indian languages, by visitors. The present writer's amateur attempts at Yana were equally unintelligible to him for a long time. An agreement was finally reached, however, on the word for the material of which his cot was made, *si'win'i,* or yellow pine. His face lightened up at this word, though he evidently could hardly trust his senses. These were probably the first intelligible sounds he had heard from a human being in three years.

Since those days he has become a regular member of the Museum staff. He has revisited Deer Creek cañon in our company, and there is not a foot of the country he does not know. There is not the slightest doubt that it has been his home. He led the party to the old lodges in the jungle at Bear's Hiding Place, he communicated scores of place-names up and down the stream for miles, and even led the way over to his old lurking places on Mill Creek, some distance to the north. In other words, he has told us all he could, in a general way, about the tribe. He has, however, been curiously backward in telling the intimate history of his own immediate group. He has gone so far as to say that the middle-aged woman who was seen was his sister, that the very old woman was

his mother, that the old man, however, was not his father. In general he speaks of them with reluctance. His reasons for this are not at all mysterious. These people are dead, and to the Indian that is ample cause for avoiding all mention of them. In the first place, if, in the world of spirits, they hear their names being mentioned, they may take it (horror of horrors!) for a summons. Hence to taboo their names or any conversation about them is mere commonplace caution. Moreover, to speak of them and their life makes the survivor sad. At worst, to mention the dead is dreadful; at best, it is a serious disrespect. For all of these reasons our surviving tribesman avoids talking of his own personal history. It is all mixed up with that of these other, deceased persons. It is impossible to discuss recent events without bringing in their names, so he usually prefers to talk of other things. He is always ready to talk at length about the general mode of life of his people—anything in fact that does not have personal details in it. He is anxious and enthusiastic in explaining his religious and mythical ideas. As a general thing, the more ancient the lore, the more volubly he discourses. We expect some day to insinuate ourselves behind his reserve, and learn the real history of his movements during the last three or four years before his "capture." His particular secretiveness in certain matters may be illustrated by the fact that he has never told us his own name. We address him usually in his own tongue as "Ishi," which means simply "man." His actual personal name is still unknown, and possibly always will be.

Two pictures are reproduced which were taken on the visit that he made in our company to his old haunts on Deer Creek. He was in familiar surroundings, thoroughly at home, told us details concerning the mode of life and enlarged in many directions on hunting and other tribal pursuits. Thus he named for us several hundred species of plants, and described in detail the uses to which his people put them. He is a very remarkable man, aside from his extraordinary personal history, and after all his hard life, very communicative and lovable. He is quite possibly, of all the Indians of North America to-day, the one who has most nearly the primitive viewpoint. His impressions of our civilization when we finally understand them will probably bring out many curious and interesting points. He will be able, moreover, to give us, from the primitive standpoint, information about a little-known chapter of history.

From time to time reports come in of evidence pointing to Indians who are still hiding away in the mountains east of the Sacramento. It is very hard in many cases to say just what the basis of these reports is. It is not absolutely impossible that there are one or more members of the Yahi group still wandering about in the wilderness. Let us hope that if there are any others of this group still alive we may ultimately succeed in bringing all of them together.

EXTINCT FAUNAS OF THE MOHAVE DESERT, THEIR SIGNIFICANCE IN A STUDY OF THE ORIGIN AND EVOLUTION OF LIFE IN AMERICA

By Professor JOHN C. MERRIAM

Introduction

IT is almost a rule that features of the natural world which have exerted an unusual influence in developing our emotional, poetic and religious natures, when brought within the range of scientific inquiry seem only more deeply to excite our wonder and respect. Thus, it has happened that the deserts of the world, having furnished the stimulus for some of our earliest poetic and religious literature, appear to the scientist of to-day as places in which nature meets us with unusual frankness, and where her wonders almost clamor to be understood.

In those fields of history covering the development or evolution of the external form of the earth and of the life upon it, deserts have been very significant sources of information, and the so-called bad-land formations in the arid or semi-arid regions of western North America have been recognized as playing a very important part. As the widespread exposures of these formations have elsewhere in America proved veritable museums of wonderfully preserved remains, it has seemed worthy of remark that the extensive bad-lands in the Great Basin region of America have with few exceptions furnished almost nothing bearing on the history of life. The early geologic explorers in Nevada and California found little bearing on the paleontologic story of the area they examined. Later investigators in the bad-lands of these regions have generally failed to report determinable vertebrate remains, and the life record has until recently remained practically a closed book. It has been with much interest, therefore, that those concerned with the history of western North America, and with its bearing on the whole story of life growth or evolution, have seen coming to light with the past decade chapter after chapter of this missing record.

With the exception of the John Day region of eastern Oregon, which supplies an important geologic and paleontologic record, the largest part of our knowledge of the history of mammalian life west of the Wasatch is obtained in the heretofore unexplored deposits of the Mohave Desert. At the present time there are available from the Mohave at least three extinct mammalian faunas previously unknown, or only imperfectly known, in the Great Basin. The life record given us by these faunas, the evolutionary series to which they contribute, and the suggestions

which they offer concerning the origin, evolution and world relationships of life in America, furnish very significant chapters in the history of the western side of the continent.

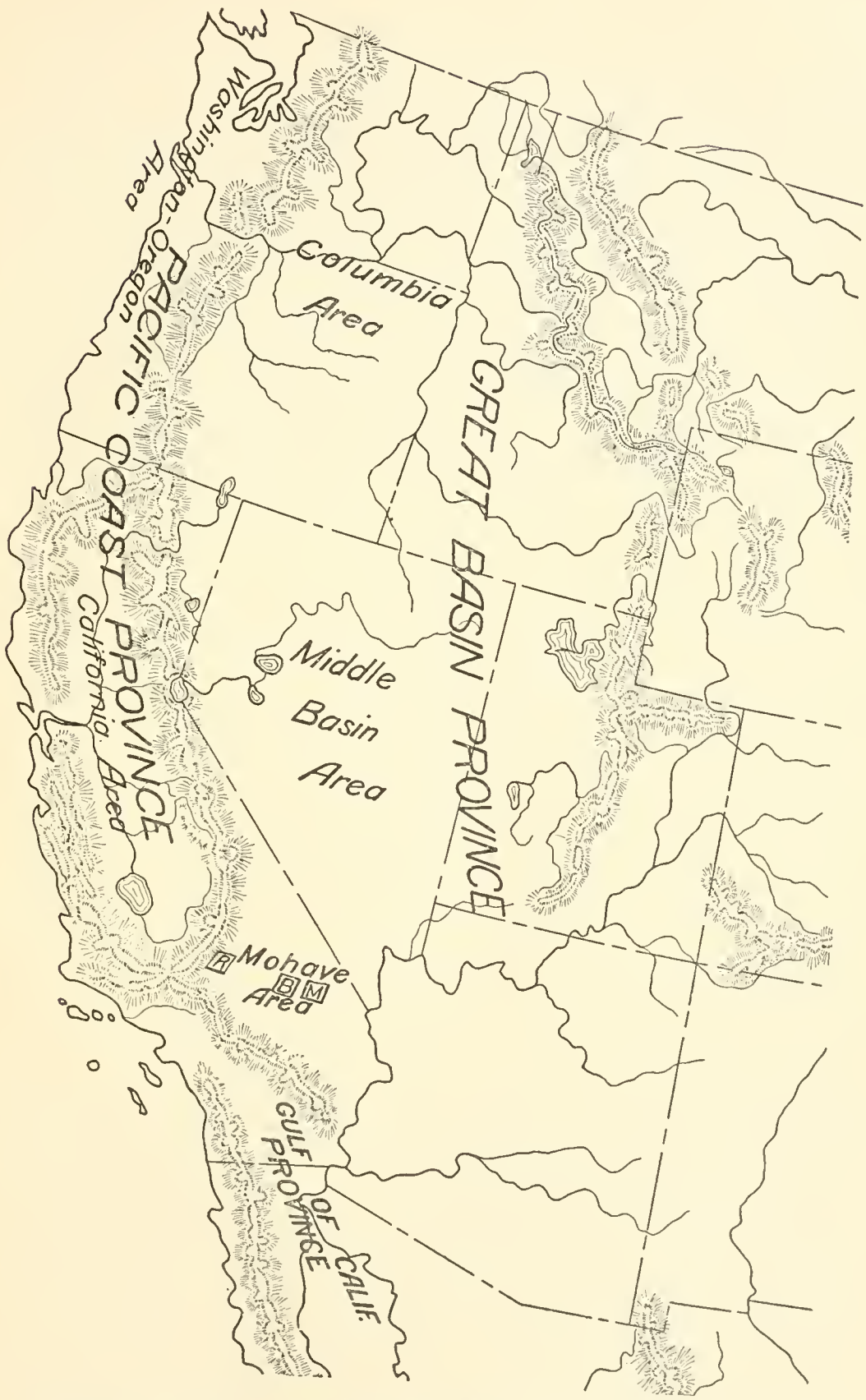
Nearly twenty years ago several very fragmentary specimens from the Mohave were forwarded to the writer by Dr. Stephen Bowers, the material having been obtained in part by John T. Reed. The earliest material from definitely known localities coming to the writer was received in the spring of 1911 from John R. Suman, then a student at the University of California. The collection consisted of a small quantity of loose bones and teeth obtained on the desert by H. S. Mourning. These specimens furnished the basis for the first study of the Upper Miocene fauna of the Mohave. In the following year C. L. Baker, a fellow in paleontology at the University of California, visited the localities reported by Mr. Mourning and secured a fine collection of mammal material from the Miocene near Barstow, and a small amount of material from the Pliocene at Ricardo. Other important collections were made later by Mr. Baker, Mr. Mourning, Mr. J. P. Buwalda and by many students in paleontology from the University of California. Following his work on the Mohave in 1913, Mr. Buwalda independently visited a locality in the eastern portion of this region, and obtained a most interesting collection of Pleistocene remains in a formation to which he has given the name Manix beds. This material gave us for the first time a representative group of vertebrates from the Pleistocene of the Great Basin.

The collections brought together at various times have opened to us a view of the mammalian life of the Mohave Desert in three periods: the Barstow fauna of Upper Miocene age, the Ricardo fauna of early Pliocene stage and the Manix fauna from the Pleistocene.

The Mohave Desert of To-Day

The Mohave Desert area of California has been generally recognized as one of the least attractive portions of the southwest. It has been described as a forbidding land of heat and thirst. The deception of its mirages is a current example of the lure of unreality, and its great stretches of sand and dust have appeared to function mainly as barriers to human progress. The history of exploration has seemed amply to justify current views concerning the desert, as year after year prospectors or explorers, deceived by distances or miscalculating the position of scattered water sources, have paid with their lives the penalty for inaccurate judgment.

In spite of seeming obstacles offered to one who would make its acquaintance, those who have come to know the Mohave seem always to cultivate the friendship. The prospector has cheerfully risked his life,



OUTLINE MAP SHOWING RELATION OF THE MOHAVE AREA TO OTHER PACIFIC COAST AND GREAT BASIN REGIONS DURING THE LATER GEOLOGICAL PERIODS. Within the Mohave region the principal faunal localities are indicated as follows: *B*, Barstow fauna; *R*, Ricardo fauna; *M*, Manix fauna.

CHARACTERISTIC VIEW OF THE MOHAVE DESERT IN THE VICINITY OF THE FOSSIL BEDS. (Photograph by C. L. Baker.)

not alone for the desire of gain, but because the fascination of the desert always increases. The traveler is inevitably deeply influenced by the uncertain magnitude of distance, by the silence, and the unusual forms and brilliance of the landscape by day and night. Once an acquaintance is formed, distrust and fear are replaced by reverence of the quiet strength of nature exhibited here in factors which are too large or too elusive to be fully comprehended.

The Mohave lies in the middle of the southern half of the state of California, the desert proper being situated in the angle where the Sierras turn west to meet the Coast Ranges. The western limits of the

CHARACTERISTIC VIEW OF THE MOHAVE DESERT: showing at this locality an unusual abundance of vegetation, consisting of creosote bushes and Joshua trees. (Photograph by C. L. Baker.)

area are sharply marked by the abruptly rising wall of the bordering mountain ranges. The limits to the east are not so clearly marked, being considered by some to reach the eastern border of the state; by others they are held to extend less than half the distance to the Colorado River.

The elevation of the desert floor ranges from 2,000 ft. approximately to 4,000 ft. above the sea, in sharp contrast to the basin of the Salton Sea, which extends below the level of the ocean a short distance to the south. The topography of the region is characterized by great stretches of open plains many miles in extent, over which scattered mountain peaks or ranges are distributed with little suggestion of order in their arrangement.

The total rainfall of the desert amounts only to a few inches per year. Living streams are rare, and travel in all of this region is necessarily limited by accessibility of the few localities at which potable water can be obtained. Rain falls largely in the middle of the winter season, and throughout the greater part of the year there is no precipitation. The water at times comes with a rush, flows off rapidly as floods, and sometimes causes considerable damage to artificial obstacles in the path of the current. With the exception of the Mohave River, which runs a thin superficial stream for a considerable portion of the year, there are very few points at which a supply of water can be obtained on the surface. Investigation has shown that artesian water is available over certain areas, and agriculturists have operated to some extent by irrigation with water obtained from wells.

The diminished rainfall, the unhindered influence of a brilliant sun and the moderate altitude have given to the Mohave a distinctly arid climate; and with the climate go all of the accompanying characteristics of life, of erosion and deposition, and of the peculiar land forms of an arid country.

The vegetation of the Mohave area is at the present time limited mainly to desert types, the contrast with the flora beyond the ridge immediately to the west being very marked. In crossing the Tehachapi Range from the Great Valley of California to the Mohave one finds the valleys of the western side thickly studded with oak, sycamore, and willow, and the hills are carpeted with grass. On the eastern slope the whole aspect of the vegetation changes suddenly, as if one were entering a foreign land. The yuccas and the creosote bush replace oak and grass, and the oddly outstretched arms of the Joshua trees seem everywhere raised up as if to attract attention. Plants of arboreal type are rare, and, excepting a few junipers, the yuccas furnish the only trees. Creosote bushes are generally present, but are sometimes sparingly represented. Perhaps to show that under adverse conditions nature means only to be just and not unkind, the spring and early summer find the

Typical Exposure of the Fossil-bearing Barstow Miocene Formation North of Barstow. (Photograph by C. L. Baker.)

desert dotted here and there with patches of flowers of unusual beauty and fragrance, offering their charms as an antidote for the misery of thirst about them.

The living mammalian fauna of the Mohave comprises thirty-five species, of which twenty-one are rodents. The Ungulata are represented only by the pronghorn antelope and the desert big-horn. The Carnivora include the desert coyote, the Mohave Desert kit fox, the California raccoon, a spotted skunk, a striped skunk, the northwest cougar, and the desert wildcat. The rodent fauna includes thirteen genera. The species are mainly characteristic desert forms. Of the living mammals only a few genera are known also in the older faunas of

Folded and Faulted Strata Representing a Portion of the Section Containing Fossil Remains North of Barstow. (Photograph by C. L. Baker.)

the Mohave. Some of the existing types, as the bighorn, are immigrants from the Old World, and arrived very late in the history of this region. Others, as the pronghorn, are evidently of American origin.

Geologic Occurrence and Age of the Mohave Fossil Beds

The Miocene and Pliocene faunas in the Mohave area occur in an accumulation of strata amounting to not less than 7,000 to 8,000 ft. in thickness. The beds consist in large part of volcanic materials which are interstratified with clay strata, shales, and desert conglomerates. The origin of the immense quantities of ashes piled up in these formations is as yet unknown. They were probably derived from volcanoes and other channels for extrusion of lavas and ash in or near the Mohave area. In a few strata abundant remains of fresh-water mollusks indicate deposition of these beds in fresh-water ponds or lakes. At other levels the skeletons of large desert tortoises and numerous remains of land mammals now characteristic of flat open country suggest accumulation upon dry land.

Mr. Baker considered that the Miocene and Pliocene deposits of the Mohave were formed mainly under physical conditions similar to those operating in the desert at the present time. As nearly as the writer can judge, the climate conditions in the Mohave area through the period in which the mammal beds were being laid down, were those of a semi-arid region somewhat more humid than the Mohave of to-day, and the climate corresponded approximately to that now obtaining in the southern end of the Great Valley of California.

Sections of the older formations containing fossils in the Mohave area are most satisfactorily shown in great thicknesses of strata exposed in the hills north of the town of Barstow, and in excellent exposures at Ricardo between the eastern foot of the Sierras and the El Paso Range. At both localities exposures extending for many miles give unusual opportunity to examine the structure of the formations, and bring to view the strata containing mammalian remains. As shown in the accompanying photographs, the formations at these localities are sculptured by erosion into most fantastic shapes, like those of the famous bad-land forms of the western Great Plains region. In the intricate gullies and caverns of these exposures there is found a most fascinating field, in which to hunt for the big game of the Mohave of ancient times.

The oldest fossil-bearing beds of the Mohave area rest upon a basement consisting in part of granite and metamorphosed or altered rocks of pre-Tertiary age. They may also rest upon extruded igneous rocks, presumably at least as old as Lower Miocene.

The oldest known strata containing vertebrate fossils in the Mohave area are found in the Upper Miocene near Barstow. Leaves stated to be of Eocene age were collected by H. W. Fairbanks at Black Mountain

TYPICAL EXPOSURE OF THE RICARDO PLIOCENE NEAR RICARDO. (Photograph by C. L. Baker.)

in the El Paso Range on the western border of the desert, but no additional material representing this stage has as yet been found.

To the whole series of older or Tertiary sediments of the Mohave area, O. H. Hershey has given the name Rosamond series. Mr. Baker has shown that the series is divisible into a number of quite distinct divisions. Some of these may represent quite widely separated periods. Evidence which the writer obtains from a study of the faunas indicates that the deposits north of Barstow containing a Miocene fauna, may represent a formation quite distinct from that at Ricardo containing a Pliocene fauna. The term Barstow formation is used for the beds containing the Upper Miocene fauna. The lower portion

EXPOSURES OF RICARDO PLIOCENE, SHOWING CHARACTERISTIC BAD-LAND STRUCTURE IN OUTCROPS NEAR RICARDO. (Photograph by C. L. Baker.)

of the Barstow section may be considerably older than Upper Miocene and may constitute a distinct formation. The name Ricardo formation is used for the strata with a Pliocene fauna at Ricardo.

The youngest fossil beds of the Mohave region appear in a small basin about 20 to 40 miles east of Barstow. The deposits cover an area about 25 miles in length and represent accumulation in a small body of fresh-water, to which Mr. Buwalda has given the name Manix Lake. The deposits consist of clays and sands aggregating about 75 feet in thickness. Their accumulation was initiated by the raising of a barrier across the Mohave River drainage, causing the ponding of the river which formed Manix Lake. The lake disappeared and deposition ceased when the river cut through the barrier across its path.

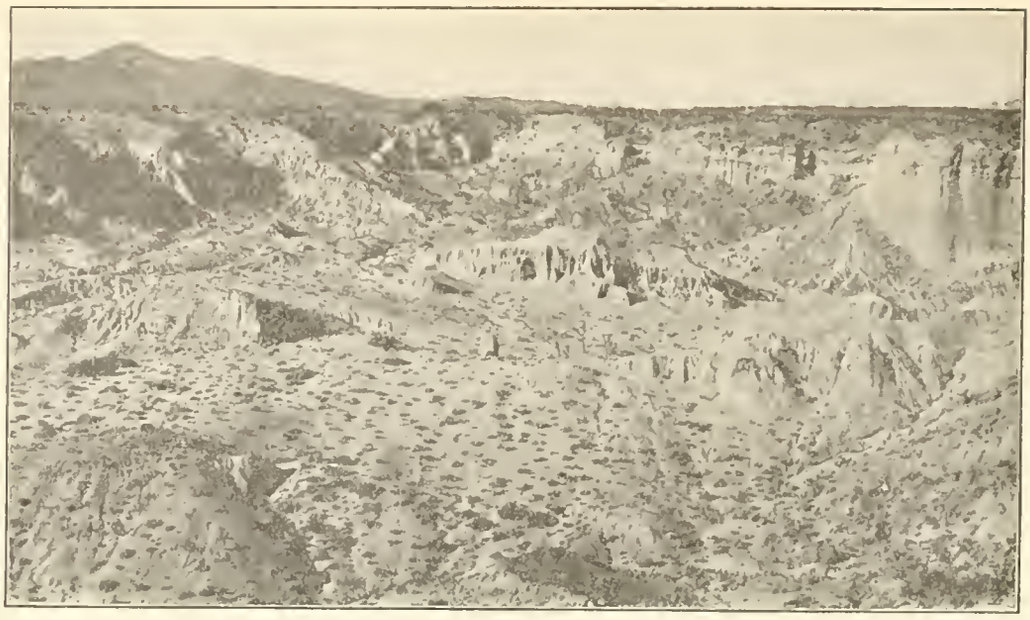
Remains of extinct vertebrates are found over a wide area in the deposits of the Mohave region. They are not abundant in many places, and one may search long for even a fragment of a bone or tooth. In a few localities fragmentary specimens were found scattered over the ground in considerable numbers, but connected parts of skeletons are rare. At several points where bones were found well exposed, and in their original position in the rock, they seemed to be scattered and disconnected, showing that the parts of skeletons were generally widely separated and broken or weathered before final burial. The process of entombment was probably similar to that in operation on the desert at the present time, where bones of horses and cattle are pulled apart by coyotes, scattered by rain-wash, and in a large measure rotted away before any portion of the animal is permanently covered over.

The collections obtained include several thousand specimens, mostly teeth and portions of limb-bones. In a few cases, good jaws and parts of skulls were secured, but unlike the occurrence in many of the formations in the west, these beds seem almost never to contain complete skeletons.

In the Miocene beds of Barstow vertebrate remains are found almost exclusively in the uppermost zone. In the Ricardo Pliocene fossil remains were found in several parts of the section, but the best representation of the fauna appears near the middle and toward the top of the formation.

Although only a few localities have been found at which even small collections of mammalian bones can be obtained in the area of the Mohave region examined, it is evident that deposits representing the formations in which bones occur are very widely spread over this area, and future exploration may be expected to add greatly to the information now available.

The formations containing mammalian faunas in the Mohave area, and their approximate relations to the recognized geological scale are as follows:



A Basin in the Ricardo Pliocene near Ricardo. (Photograph by C. L. Baker.)

Geological Periods		Mammal Beds of the Mohave Area	Recognized Formations of other Western Areas
Pleistocene		Manix Beds	Rancho La Brea, California
Pliocene	Upper		
	Middle		
	Lower	Ricardo Beds	Thousand Creek, Nevada Rattlesnake, Oregon
Miocene	Upper	Barstow Beds	Cedar Mountain, Nevada
	Middle		Mascall, Ore. and Virginia Valley, Nev.
	Lower		Columbia Lava of Oregon

Ricardo Pliocene at Ricardo. This is one of the most important fossil 'ocalities in the Ricardo formation. (Photograph by C. L. Baker.)

The Oldest Known Mammal Fauna of the Mohave, the Upper Miocene of Barstow

The fauna of the oldest mammal-bearing beds of the Mohave area includes about thirty species, many of which are known only by fragmentary material. The larger part of the collection consists of the remains of horses and camels. The bones of horses, accompanied by those of other animals, are sufficiently abundant at one horizon to mark a zone or layer which can be traced for a number of miles, and is known as the Merychippus zone, from the most common fossil, a little three-toed horse of the genus *Merychippus*.

Of the horse there are at least four species represented. *Merychippus* is the most abundant form and includes two or three types. They were mainly animals about as large as small colts of the modern horse. They possessed one large middle toe and two small, scarcely-functional side toes on each foot. Their heads were long and had peculiar depressions on the sides of the face. The back-teeth were long, and as they were worn off from the top, they grew up from the root, as in the modern horse. These animals were of a distinctly open country or plains type, and evidently supported themselves by grazing or grass-feeding, rather than by browsing from brush as do the deer. One of the larger species of *Merychippus* is almost indistinguishable from the genus *Protohippus,* the next or later stage in the evolutionary series of the horse. An exceedingly rare form related to *Merychippus* is represented by a few large teeth which may possibly belong to a representative of the genus *Pliohippus,* a larger animal somewhat like the modern horse. One of the most common *Merychippus* species is a small form approaching in its characters the genus *Hipparion,* the characteristic horse of the following Ricardo or early Pliocene epoch. The Ricardo Hipparions are possibly descendants of this small Barstow horse.

Two rare horses found in the Barstow fauna, like the earliest forms of the horse group, have back-teeth with short crowns not adapted for grazing. One belonging in the genus *Hypohippus* was a large three-toed animal, in which the side-toes are much larger than in *Merychippus.* The teeth are those of a browsing, not of a grazing animal. The feeding habits of this horse must have differed very considerably from those of *Merychippus,* and it probably occupied a somewhat different range. The other rare form represents a species of *Parahippus,* also of a browsing rather than of a grazing type. It may be repeated that *Hypohippus, Parahippus* and *Protohippus* are collectively known only by a very small number of specimens. The grazing *Merychippus* is the common and characteristic animal of the fauna.

Associated with the horses are rare remains of a primitive wild pig or peccary. There is also a rare oreodon, one of the late representatives of a large family, which is perhaps the most characteristic American

CHARACTERISTIC EXPOSURE OF THE MANIX PLEISTOCENE LAKE-BEDS ON THE NORTH BANK OF THE MOHAVE RIVER NEAR FIELD STATION IN THE MANIX BASIN. (Photograph by J. P. Buwalda.)

mammal group in the whole history of our fauna. It included creatures resembling on the one hand the pigs and on the other hand the camels and deer. There are also rare remains of a large antelope or deer of the genus *Dromomeryx*. A small deer-antelope, *Merycodus*, a dainty creature with teeth like an antelope and horns like a deer, is represented at several localities by abundant fragments of teeth, limb-bones and

BAD-LAND STRUCTURE IN THE MANIX BASIN. (Photograph by J. P. Buwalda.)

antlers. A large four-tusked mastodon is known by numerous fragments and occasional complete bones or large pieces of tusk.

Next to the horses the most numerous of the hoofed animals are the camels. They are known by at least three types. One is a small form of the genus *Procamelus*. A second and very large type probably belongs to the genus *Pliauchenia*. A third form with very large long limbs, a larger animal than the living camel, is possibly to be referred to the genus *Alticamelus*. Other genera may be present in the collection.

Of the remaining fauna, the rodents are represented by rabbits. The carnivores are known by at least eight species, including three large cats, at least one of which is a sabre-tooth with the greatly developed upper canine teeth. Two others may belong to the true cats, represented by the modern puma and wild cat, without the saber-like upper teeth. The dogs include one small form similar to the fox. A second type, *Tephrocyon,* one of the most characteristic animals of this horizon, is a form considered by many to be possibly the ancestor of the modern dogs and wolves. The most abundant creatures of the dog group are found in one or two representatives of the genus *Aelurodon,* very large, very heavy-jawed animals, much larger than any modern wolves, and even greatly exceeding the extinct dire wolf, now so well known by abundant skeletons from the asphalt deposits of Rancho La Brea. These animals were evidently not rare. They probably lived off the herds of large ungulates, sometimes bringing down a live animal, sometimes robbing the smaller wolves and the big cats of their prey. Their unusually massive jaws and teeth seem built to serve as bone crushers, and there can be little doubt that the general state of dismemberment and destruction of all skeletons, and the absence of satisfactory paleontologic materials in the Barstow formation, is due in large part to the destruction of these scavengers.

Birds are known in the Upper Miocene beds by a few fragments representing an owl. Reptiles are represented by numerous fragments, and several nearly perfect skeletons of a large tortoise resembling in many respects the living desert tortoises of the Mohave.

The fauna of the Upper Miocene is as a whole that of an open country affording fairly abundant grass and herbage, and evidently better watered than the Mohave Desert of the present day. The numerous remains of grazing horses of the *Merychippus* type, the presence of mastodons, oreodons, of many deer-antelope, a considerable variety of camels, and a wild pig all indicate that grass and other nutritious vegetation must have been more abundant than at present. The relatively small representation of oreodons, and of browsing horses like *Hypohippus,* and the presence of large tortoises are possibly to be correlated with open semi-arid character of the country.

That small bodies of water were present at times in this area is

shown by the presence of many fresh-water molluscan remains at certain horizons.

The fauna of the Barstow beds represents a stage in the evolution of Tertiary mammalian faunas previously not distinctly recognized in the Great Basin Province. It seems clearly later than the Middle Miocene life stage well known in the Mascall beds of Oregon and in the Virgin Valley beds of northern Nevada. The fauna is markedly older than the Rattlesnake Pliocene of Oregon and the Thousand Creek Pliocene of Nevada, representing the next described stages following the Middle Miocene in the Great Basin. The fauna of the Barstow beds has few if any species in common with that of the Ricardo formation, and is of a distinctly older type. Its nearest relationships are with the fauna of the Cedar Mountain region of southwestern Nevada, from which it possibly differs somewhat in stage.

The Second Fauna, the Ricardo Pliocene

The number of species represented in the Ricardo fauna is approximately equal to that found in the Barstow Miocene and the groups of animals represented are in general of the same type. Comparisons between these two faunas or life stages can therefore be made with some degree of satisfaction. Coupled with the fact that the Mohave and Ricardo faunas comprise an approximately equal representation of similar groups, it is a matter of interest to note the almost complete difference between the species represented in the two, and that with one or two possible exceptions the species of the Ricardo stage represent more specialized or more progressive stages of evolution than the corresponding types seen in the Barstow fauna.

As in the Mohave stage, we find the Ricardo collections consisting mainly of horses and camels, the horses furnishing the most important and most characteristic forms thus far known.

The Ricardo horses are of at least three types, of which the most common includes one or more species of the genus *Hipparion*. These are large, three-toed forms with the side-toes reduced and the grinding teeth large. They resemble to some extent one of the small species of the Barstow Miocene, but are much larger; the side-toes are more reduced; and the teeth were longer-crowned, heavier, and of more complicated structure. The Ricardo *Hipparion* differs from most of the species referred to this genus in America, and belongs to the true *Hipparion* type, which J. W. Gidley considers as characteristic of the Old World, in contrast to a New World form, *Neohipparion*. Many of the teeth of the Ricardo species are practically indistinguishable from those of *Hipparion richthofeni*, a species abundantly represented in the early Pliocene or late Miocene of China. It has generally been assumed that the Old World horses of the *Hipparion* type are descended from

North American stock. No types from which *Hipparion* might presumably be immediately derived by evolution are known in the Old World formations of the period just anterior to that in which *Hipparion* first appears, whereas in North America stages of evolution leading toward *Hipparion* are found in formations representing the period preceding the birth of this genus. So far as the writer's observations have been carried, an evolutionary sequence leading to the genus, *Hipparion* is nowhere more clearly suggested than in the relation of the *Hipparion* of Ricardo to the Hipparion-like *Merychippus* of the Barstow Miocene. It seems not improbable that the Old World *Hipparion* is derived from a West-American form near the Barstow *Merychippus*.

Living in the same region with the *Hipparion* in Ricardo time were at least two other types of horses of an advanced stage referred to the genus *Pliohippus*. The animals of these species were nearly as large as the smaller forms of the modern domestic horse. Their teeth were long-crowned and well adapted to grazing as in existing forms, but their feet still bore small side-toes somewhat as in *Merychippus* of the Barstow. The pattern of their teeth is quite unlike that of the *Hipparion* and considerable differences separate them in skeletal structure. They presumably occupied a different niche in the organization of the fauna, but what it was is not entirely clear.

In the Ricardo fauna, as at Barstow, we find a rare oreodon, the last representative of this important family known west of the Wasatch. The Ricardo type follows the rule in being more specialized than that in the Barstow Upper Miocene. Little deer-antelope much like those of Barstow are also known by the last representatives in the Great Basin. Rodents are rare. The mastodon group is still represented by animals with four tusks, a pair being present in the lower jaw as well as one in the upper jaw.

Of the camels there are several species known from Ricardo. They represent genera similar to those in the Barstow Miocene, but are generally of larger type, and are presumably in a large part specifically different. Carnivores are relatively abundant. Large heavy-headed ælurodons like those of Barstow are present, but possibly all belong to new species. With these are other forms of the same group, but larger and stronger. There is a marten of a new species. Of the cats, one is a saber-tooth of a rare type somewhat similar to a species known in India. One specimen, belonging to a gigantic animal of the *Felis* or true cat type, was at least as large as a male African lion of the present day. Another specimen is from a smaller cat possibly like a puma.

Large tortoises are known in the Ricardo, as at Barstow. At least one form seems to differ in its character from the Barstow species.

In the table on page 262 a comparison of the Ricardo and Barstow faunas would show almost complete specific separation of the life stages.

This difference extends in a considerable measure to groups of the rank of genera; as in the case of the horses, in which *Hipparion* replaces *Merychippus*. As has been noted above, in nearly all cases in which it has been possible to make a satisfactory comparison of animals in similar groups, the Ricardo types are seen to be more specialized or more progressive. In the Carnivora the common *Tephrocyon* of the Mohave seems to have disappeared. A single specimen shows some resemblance to that genus, but is not comparable to any Barstow species. The heavy-jawed ælurodons, which are the characteristic canids of the Ricardo fauna, seem to be mainly, if not entirely, distinct, and are generally more specialized than those from the Barstow beds.

The fauna of the Ricardo beds is widely different from that of the Middle Miocene west of the Wasatch, and is distinctly more advanced in the stage of progress or evolution. It is quite different from the Lower Pliocene of Thousand Creek of Northern Nevada, and seems less advanced. It differs so far as known from the Rattlesnake Lower Pliocene of Oregon, and is possibly somewhat older.

The beds in which the Ricardo fauna occurs were evidently deposited on plains lying at the eastern base of a Pliocene Sierra range rising to a height of several thousand feet above the level of the Great Basin region. The elevation of the Mohave area as a whole was probably not greater than at present, and may have been somewhat less. The Ricardo deposits are probably in part land-laid and in part water-laid. The volcanic material which they contain may at times have accumulated rapidly, but seems in general to have been deposited so slowly that the region was nearly continuously habitable.

The Ricardo fauna consists largely of forms that would naturally prefer to inhabit plains areas, or might thrive in partly open, level regions at least as well as in other environment. *Hipparion, Pliohippus,* the camels, and *Merycodus* would find this a favorable habitat. The carnivores associated with them would not necessarily find the surroundings unfavorable, provided sufficient cover were available. The mastodons and oreodons might inhabit the plains or frequent the border of the mountain area to the west. There are no elements in the Ricardo fauna which are necessarily considered as representatives of a forest or mountain assemblage washed or carried out on the plains.

The Ricardo fauna suggests climatic conditions permitting the development of vegetation suitable for grazing animals. This indicates a somewhat heavier growth of grass than is found in the Mohave at the present time. There is nothing in the constitution of the fauna to suggest conditions radically different from those obtaining in this region to-day, but the presumption is in favor of less extreme aridity than is now known on the western border of the desert. The conditions obtaining here in Ricardo time were probably more nearly like the

present environment in the southern portion of the Great Valley of California.

The Latest Extinct Fauna of the Mohave, the Manix Pleistocene

The fragmentary remains obtained by Mr. Buwalda from the deposits of Manix Lake include only scattered bones and teeth with a few shells of snails and clams. The collection includes the bones of two horses of the genus *Equus*. One is a large species evidently closely related to the existing horses. The other is a much smaller form, but evidently of the same genus. There are two camels; one near the size of the dromedary, the other much smaller. The larger camel was probably near or incidental with the large *Camelops* known by splendid specimens from Rancho La Brea. The other species is unlike any Pleistocene camel described from the west. There are bones of a proboscidean, probably an elephant. A large antelope, probably like the pronghorn is known by a single bone. Two birds like existing species are found in this fauna. The molluscs are fresh-water species closely related to living forms.

As fragmentary as is the material from the beds of Manix Lake, it represents the first assemblage of mammalian species of Pleistocene age from a definitely known horizon in the Mohave region. It is, in fact, the most important collection made at any single locality in the Pleistocene of the Great Basin. It gives for the first time a grouping of the most important mammalian forms living together in this region at any particular stage in the Pleistocene.

Taken alone these fragmentary specimens might never tell more than a very short story, but the wonderful Pleistocene collection obtained at Rancho La Brea just across the range to the west will ultimately furnish comparative material adequate to make possible a definite determination of the animal represented by every bone found in the Manix beds.

The Manix fauna is entirely distinct from that of the Ricardo. The horses are of the latest and most advanced genus, that is the modern *Equus,* which includes most of the living representatives of the horse group. The larger camels seem to represent the last genus known in North America. The relationships of the smaller camel are as yet uncertain. If the antelope is near the pronghorn, as seems probable, it is also of the latest known type.

It is perhaps unnecessary to state that the Manix fauna differs from that of the present day in the inclusion of camels and a proboscidean. When it is better known, this fauna will probably be found to contain few if any modern species.

COMPARATIVE TABLE SHOWING KNOWN HISTORY OF THE MAMMALIAN FAUNAS IN THE MOHAVE AREA.

RECENT	PLEISTOCENE	PLIOCENE	MIOCENE
DESERT FAUNA	MANIX	RICARDO	BARSTOW
Reptilia	*Reptilia*	*Reptilia*	*Reptilia*
Tortoise		Tortoise, large	Tortoise, large
Rattlesnake			
Carnivora	*Carnivora*	*Carnivora*	*Carnivora*
Desert coyote		Aelurodon, 3 species (Heavy-jawed dogs)	Aelurodon, 2 species (Heavy-jawed dogs)
Desert kit fox			Tephrocyon (Possible ancestor of modern wolves)
		Dog, small	Dog, very large
		Ischyrosmilus (Sabre-tooth cat)	Dog, small
Cougar		True cat, very large	Sabre-tooth cat, large
Desert wild cat		True cat, medium size	
			True cat, very large
California raccoon		Marten	
Spotted skunk			
Striped skunk			
Ungulata	*Ungulata*	*Ungulata*	*Ungulata*
	Equus, large (Horse)	Hipparion, 2 species (Advanced grazing-horse, 3-toed)	Hypohippus (Forest-horse, 3-toed)
	Equus, small (Horse)	Pliohippus, 2 or 3 species (Advanced grazing-horse, 3-toed)	Parahippus (Browsing-horse, 3-toed)
			Merychippus, 3 forms, abundant (Grazing-horse, 3-toed)
			Protohippus, rare (Advanced grazing-horse, 3-toed)
	Camelops? (Camel, large)	Procamelus?, (*a*) (Camel, small)	Procamelus (Camel, small)
	Camel, small	Procamelus?, (*b*) (Camel, small)	
		Alticamelus? (Tall camel)	Alticamelus?, (Tall camel)
		Pliauchenia? (Camel, very large)	Pliauchenia? (Camel, large)
		Merycochoerus?, (*b*) (Oreodon)	Merycochoerus (*a*) (Oreodon)
Prong-horn antelope	Antelope, large (Prong-horn?)	Merycodus (Deer-antelope)	Merycodus (Deer-antelope)
			Merycodus? (Crowned deer-antelope)
			Dromomeryx (Antelope-deer)
Desert bighorn sheep			
	Proboscidea	*Proboscidea*	*Proboscidea*
	Elephant or Mastodon	Tetrabelodon? (Four-tusked mastodon)	Tetrabelodon? Four-tusked mastodon)
Rodentia	*Rodentia*	*Rodentia*	*Rodentia*
Numerous genera and species	Fragments only	Fragments only	Fragments only

At the present time we are not in a position to state definitely the exact position or relationship of the Manix fauna with relation to other Pleistocene life in the west. The problem of the Pleistocene in this region is complicated and large, and the many elements still require much study before their interrelations can be determined. The Rancho La Brea fauna seems to contain elements similar to those of Manix, whether it is older or younger is not yet entirely clear.

The significance of the Manix fauna in relation to its environment is unfortunately not large. The presence of camels, horses, and antelopes indicates a climate somewhat more humid than that in this region at the present time, and such was the suggestion furnished by Mr. Buwalda's work on the physical history of the Manix Lake basin.

Significance of the Faunal Succession in the Mohave

The physical history of the Mohave area, in the time that has passed since the accumulation of the oldest formation containing a mammalian fauna in this basin, is only a small part of the long and complicated geologic story of the region; but the changes that have occurred since the earliest of these records of life were completed take on stupendous proportions when measured against human standards of stability. Since the deposition of the oldest beds of the Barstow section, not less than 8,000 ft. of known sediments have been laid down in this region, and there are evidences of long periods from which the only record that we have is of erosion instead of deposition. The strata of both the Barstow and Ricardo sections have been subjected to extreme movements of the earth's crust in folding and faulting or breaking. They have also been extensively eroded or worn down, and the strata now exposed can be considered only as remnants of the original mass. In terms of accumulation and erosion of deposits, judged by the best estimates that we can make, the lapse of time since burial of the oldest mammal remains in this region must be very long.

Physical changes of great significance in the history of this region, and of the life in it, are also noted in variations in the nature of the bordering mountain ranges. At present the Mohave owes its distinctive characters in large measure to separation from the Pacific coast by high ridges to the west. Throughout a large part of the known life history of this region, a barrier seems to have existed between the Mohave area and the Pacific coast province. The height of the separating wall has presumably varied much, being relatively small in Miocene time, and probably reaching its maximum since the Ricardo Pliocene. Variation in height of the barrier depended on the balance between erosion constantly wearing it down, and on the magnitude of crustal movements concerned in the making of the mountain chains. To some

extent variation in physical conditions in the Mohave has therefore been related to stages in the life of our great ranges. The latest period in the history of the mountains is the stage in which the peaks and valleys were modeled to their present form through gradual wearing down by ice, water and chemical decay. The clearly visible evidences of this last epoch mark for us a period longer than the full span of human history. In the story of the mountains, the earlier stages standing in relation to the history of life on the Mohave are observed only through study of a complicated geologic problem, but the measure of these early stages in time is far longer than that of the latest epoch.

The Barstow, Ricardo and Manix faunas present three stages in the life history of the Mohave area within the extent of a long period marked by many great physical changes. The records of these faunas are incomplete, and should be considered only as imperfect pages from a volume that has passed through fire, flood, earthquake and decay incident to the passage of almost limitless time. As fragmentary and unsatisfactory as the story is, it opens to us a wide vision of previously unknown life history in this region; it offers significant evidence regarding the origin, evolution and migration of important mammal groups; it furnishes information concerning the climatic history of the Mohave; and it contributes largely to our knowledge of the chronology of great crustal movements in western North America. If this were the only record known in the world, from it alone we could gather evidence that the life of the earth is very old, that this life has completely changed from time to time, and that in each successive fauna there was a nearer approach to the life types now in existence. We might not be able from the Mohave story to demonstrate the fact of evolution, as the fragments are small, and represent periods so widely separated that the suggestion of continuity is indistinct. Taken in connection with the great volume of records now available from other regions of the world, the Mohave story serves in a modest way to fill gaps in the previously known history; and in its close relationship to faunas remotely separated from it geographically, it illustrates the faunal unity of the world as a whole when the broader outlines of evolution are followed through long periods.

The story of the Mohave read alone cannot do less than impress one with the magnitude of faunal changes and with their apparent definite trend toward the life of to-day. Related to other records, it becomes a part of the great world-scheme of life growth or evolution leading up through the ages to the present living world of which we are a part.

INSECTS OF THE PACIFIC

PROFESSOR VERNON L. KELLOGG

WHEN one speaks of the insects of the Pacific, they are the insects of the Pacific shores and Pacific islands that one refers to. For with all the amazing adaptiveness of insects to variety of habitat and habit, and with all the pressure of enormous numbers of species and individuals to drive them far and farther and into all the available places of earth, the insects have, curiously, so far not invaded the oceans. Although they constitute of known living animal kinds a full two thirds, perhaps three fourths, they are restricted in habit to but one third part of the earth's surface, to wit, its dry land and fresh and brackish waters. The real salt sea is tenantless of insects. A few long-legged surface-treading kinds are found on ocean waters far from land, but these are really inhabitants of surface sea-weed patches, which, like their fresh-water cousins, the familiar water-striders or skaters of ponds and quiet stream-pools, can run or glide quickly over the water's surface, denting but not breaking the supporting surface film.

There are also a few small kinds which haunt the beaches and rocks between tide lines for sake of the rich harvest of food thrown up by the waves. Such a kind is a little long-legged fly with atrophied wings, which lives on the headlands of the California shore in the Monterey Bay region. When the tide is out it runs actively about, looking like a small slender-bodied spider, over the rough, damp rocks between tide-times, seeking bits of organic matter thrown up by the waves that dash over the rocks at high tide. When the waters come back these odd little flies seek refuge under small silken nets they have spun across shallow depressions in the rocks. They cling desperately to the under side of the protecting silken mesh, while the great waves dash and break over them. Of course they are much of the time actually submerged in salt water. But they stand it.

Recently a similar and closely allied fly has been found on the shores of bleak South Georgia Island in the South Atlantic about 500 miles east of Patagonia. And another tide-rock fly of like habits is known from the cold and tempestuous Kerguelen Island of the South Indian Ocean.

The insects of the Pacific Islands are, however, more conspicuous by the kinds familiarly known all over our continent than by the sorts peculiar to the islands. In fact, what with the same old house-flies and blue-bottles, mosquitoes and fleas, cockroaches and bedbugs, and other familiar close companions of man, the insect fauna of a Pacific island or of the Pacific coast of America is likely to be disappointingly familiar and familiarly troublesome.

But this familiar character of the first seen and most often seen insects of the Pacific points an important moral to the student of insect distribution and of insect troubles. It is the moral of man's personal aid in the wide dissemination of insect pests. Wherever he goes, by wagon, train or ship, he carries the pests with him, colonizes them wherever he settles, and supports them in their new homes by his own presence and the presence of his domesticated animals, his quickly planted grains and vegetables, fruits and flowers.

So the casually inquisitive visitor to Pacific lands will find himself irritated by the same kind of fleas, mosquitoes, buzzing flies and biting flies, nocturnal bed-fellows, the same old croton bugs and black beetles and the rest that he knows in the east and middle west.

They have all come to California and Oregon and Washington, and gone on to the Hawaiian and Samoan and Philippine Islands, just as many of them came from Asia to Europe and Europe to the Atlantic and went on to the Mississippi Valley in earlier years. And this emigration and immigration by the side and with the aid of man accounts for a considerable and, from the economic point of view, a very important part of the Pacific insect fauna. For most of the worst insect pests of California and the rest of the Pacific coast are imported and comparatively recently imported species.

The most important single group of insects to the citrus and deciduous fruit growers of California are the scale insects (Coccidæ), small, degenerate, specialized, wax-covered and protected sap-sucking creatures, of hardly the seeming of an insect at all. The San José scale, the cottony-cushion scale, the black scale, the soft brown scale, the red orange scale, and all the rest of the scaly crew are ever threatening clouds on the fruit-grower's horizon. And he spends annually much time, energy and money in fighting back the swiftly multiplying hordes of these pests.

Now practically all of them are natives of other lands; they are man-aided immigrants into California. The San José scale, that once threatened the whole deciduous fruit interest of California, came from China about 1875. The cottony-cushion scale that similarly once threatened all the citrus orchards came from Australia about 1868. And the story of the coming, and settling, and finding the country good, of several of the other kinds is as well known.

But, fortunately, the economic entomologists have learned something to their advantage from this kind of insect immigration. They have learned deliberately to hunt for and import good bugs to fight the bad ones. For example, it was discovered that the Australian cottony-cushion scale, so dangerous a pest in this country, was not so dangerous in Australia, and this because of the active efforts made there by a certain kind of little black-and-red lady-bird beetle known as the vedalia. The

scale pest had got carried to America without its vedalia enemy, and, accordingly, found California in truth the promised land. Now what more common-sensible than deliberately to import and colonize vedalia in the California orange and lemon orchards? Which was, accordingly, done, and done easily and successfully, so that here, as in Australia, vedalia keeps the cottony-cushion scale insect within practically harmless bounds.

Naturally such a success has led to many other attempts in many other similar cases. Perhaps no other success has been so marked as the now classic first one, but much other success there has been, both on the Pacific coast and on Pacific islands, notably Hawaii, and also in the eastern states. The great fight against the imported foliage and forest tree pests of New England, the direful gipsy and brown-tail moths, is resolving itself more and more into a search for and colonizing of their natural parasites in Europe and Japan.

Another type of good bug brought to the Pacific coast by deliberate importation and carefully nursed to an effective colonization is the curious little fig-wasp, *Blastophaga,* by whose means the "caprification," *i. e.,* pollination, of figs depends, on which depends, in turn, the full size, sweetness and the nutty flavor of the best commercial figs. The fig is a hollow but fleshy receptacle with many minute flowers inside. The *Blastophaga* eggs are laid in the ovules of these flowers, and there the tiny grub (larva) lives and feeds and changes finally into a little chrysalid, and then adult. The adult male *Blastophaga* is a curious deformed wingless creature, and remains in the fig of its birth until it dies. But the female is a winged active insect that leaves its natal and cradle fig and flies to others to lay its eggs. Curiously, it can find suitable egg-laying places only in the wild or so-called capri figs and so does not leave eggs in the cultivated figs, but in walking about over their flowers it dusts them with pollen brought from the fig last visited, and thus produces the necessary cross-pollination. As the *Blastophaga* lays no eggs in the domestic figs, it is necessary to keep a few wild fig-trees growing in or near the orchard.

But not all the Pacific coast insects are excessively bad bugs or excessively good ones. Some call for attention because they are just beautiful, or singular, or of unusual habit or habitat. And these are likely to seize the interest of most of us more certainly than the pests. For, after all, our interest in nature is not primarily one of dollars and cents. It is one of curiosity and of "wanting to know."

A matter that lends California's fauna and flora a special interest to naturalists is the peculiar biogeographic situation of the state. Biologically, California is essentially a large island, shut off by barriers of actual water on one side and by hot desert and high cold mountain ranges on the other, with the ends also nearly similarly barred by desert

and mountain. This results in her showing the characteristics of an island fauna and flora, with their numerous monotypic plants and animals, unique, solitary kinds, developed in isolation and under special local conditions. California's insect fauna, therefore, includes many unique species and genera, and even a few families, not found elsewhere on this continent, not even in other neighboring states. This makes it an exceptionally happy hunting-ground for the insect-collector and systematist.

But not only does its biological isolation give an exceptional interest to its insect kinds, but its extraordinary topographic and climatic diversity introduces unusual and highly contrasted conditions in insect living and, through environmental influence, produces strange kinds of specialization of structure and habit. For example, the brave little butterflies (*Chionobas*) that live on the summits of the Sierra Nevada are bound to attract our attention, for their nearest cousins (other species of the same genus) are similar butterflies confined to the summits of the Rocky Mountains, 1,000 miles away, and Mt. Washington in New Hampshire and Mt. Katahdin in Maine, 2,000 miles farther. These lonely mountain-top butterfly kinds are good illustrations of the fact that altitude can replace latitude in distribution. And they undoubtedly owe their marooning on widely separated peaks to their neglect to follow the retreating glaciers of the close of the Great Ice time northward, remaining, instead, in these isolated alpine regions where conditions have remained practically glacial.

The California mountains, especially the Coast Range, have another especially interesting group of insect inhabitants in a curious small family of delicate, long-legged, stream-haunting flies called net-winged midges (Blypharoceridæ). Although scattered widely over the world in mountain regions, hardly more than a score of species are known, of which almost one half are peculiar to the Pacific coast. Their immature life is passed, as larva and pupa, in the swiftest and clearest of mountain streams, clinging by strong little sucking pads to the smooth rock bottom on the verge of a fall. The larvæ die if they happen into slow or stagnant water, and many of the delicate flies are torn away by the current and lost as they emerge from the pupæ. But, nevertheless, with all this restriction of life to certain narrow and dangerous conditions, the net-winged midges, like the water ouzels, near whom they domicile, maintain a successful existence to add to our interest in the mountain streams.

Another interesting group of insects, well represented in California and very sparingly elsewhere in this country or anywhere out of the tropics, is the family of termites, or white ants (Termitidæ). Indeed, out of the seven species known to occur in the United States, but one is found in the east, the other six being limited to the southwest and

Pacific coast. Three species occur in California, of which two are common and constantly met with. One (*Termopsis augusticollis*) is unusually large, and makes its communal nests in fallen pine-trees, telegraph and telephone poles and other dry wood. I have found colonies containing thousands of individuals in fallen trunks of the great trees of the Sierran forest.

Another group of interesting insects unusually well represented in California are the gall-flies (Synipidæ) which form the galls, or, better, stimulate the trees to form the galls, on oaks. Seventy species of these odd little flies have been listed for the state, and there are others in Oregon and Washington. As each species has its own special kind of gall, the oak-trees of the Pacific coast often bear a curiously variable load of "fruit" besides the acorns.

I should like to speak of some of the west-coast insects of unusual appearance or pattern, the kind that catch the eye of the most casual traveler, such as the giant, tarantula-killing, bronze-winged, blue-black Pepsis wasp, that indulges in battles-royal with the big hairy tarantulas and trap-door spiders, which themselves, though not insects, are near enough related to them to warrant mention in any account of our insect fauna. But I may not. I may not speak for them at all except to say that California will match its insects against the similar fauna of any other state for interest and opportunity for fascinating observation and profitable study.

THE PHYSIOLOGICAL ASPECTS OF CALIFORNIA FOR THE BOTANIST

By Professor GEORGE J. PEIRCE

IT is almost absurd to speak under one title of a region which forms the Pacific coast of the United States for a distance equal to that from Key West to New York, which extends from sea-level to almost three times the height of Mt. Washington and from the Pacific eastward as far as Utica lies from the Atlantic. But geography and topography merely make, with the assistance of other factors, those complexes which we call climate and soil. There are, therefore, all sorts of climate from sub-tropical to Arctic,—air which ranges from dripping to dry, water which is sweet and water which is brine, growth which is constant the year round or as regularly periodic as winter and summer in the intemperate parts of the "temperate" zone. There are districts in which the daily range in temperature is greater than the seasonal range, soil which bakes to brick and soil which blows in the breeze, and, in places, light which in amount and in composition is equaled in few other parts of the known world.

If we summarize these statements we shall see that, so far as plants are concerned, it is the condition and the amount of water in air and soil which is the most striking factor in their environment. Water is not only an indispensable food material and the medium in which all the other food materials enter the plant, but it also regulates the kind and the quantity of light which reaches the earth's surface. By so doing it regulates the prevailing temperatures also, possibly to a greater degree than many of us realize.

Water, a simple, stable compound chemically, we seldom think about, taking it for granted when we have it, grumbling when anything interferes with its supply either in quantity or convenience. The average attitude of civilized man to water is similar to his feeling about the daily newspaper. He thinks little or not at all about the labor of mind and body involved in the regular delivery of the daily paper at breakfast-time at his front door. And if he thinks of water at all, it is only liquid water, of which he demands a supply ample and safe, at his hand by the turn of a faucet. Yet this flowing water is only a small part of what he needs. The water in the pipes is but a small fraction of the total upon which not only his comfort, but also his very life depends. The water in the soil, brought thither as snow or rain, or by stream and possibly by irrigating ditch, is vastly more necessary than the water in

the pipe. The soil water, added to by rain and stream, conserved by cloud and fog, is still further preserved, for the plants which receive it into their roots, by the invisible moisture in the air. For the greater the humidity the less the evaporation from soil and living body, from plant and animal alike. Water is always present, wherever there is a living thing, because, in addition to what is taken into the living body, water is formed in the body and in every cell in which respiration is taking place. The liberation of carbon dioxide in plants and animals is but part of the chemical process which is called respiration. Along with carbon dioxide, water also is formed in the oxidation of the carbon compounds which form the bulk of our food. This is exhaled, or escapes by evaporation, with the carbon dioxide, or is carried off or used. The character of the organism and the nature of the environment determine the amount and the manner of the loss of water by the body.

These are all truths of which we become conscious on reflection, but unless contrasting environments are close together, we are not likely to become conscious of them. In the Rocky Mountains one may see the timbered slopes of one side facing the grassy slopes across the valley. On the Pacific coast, chapparal and forest cover the opposing slopes, meeting at the stream-bed and at the head of the narrow valleys between the ridges of the Coast Ranges. Not the fires of the Indians nor the clearings of the whites account for these contrasts, but rather the relations of the opposing slopes to water, its supply and its loss.

The long valley in which lies the Bay of San Francisco is bounded by ranges of mountains, mainly parallel but strikingly different on the two sides. On the western shore of the Bay, gently rising to the mountain rampart which bars the Pacific Ocean from access, forests and dense shrubby growths, chapparal, cover the still uncleared slopes. The forests are heaviest in the passes, for though the rainfall may be little or no greater there, and the run-off no less rapid, the passes are fog channels. Through these channels the ocean fogs flow, bringing moisture and saving moisture in soil and vegetation. The plants of these east and west passes are strikingly different from those of the cañons which head into the mountain barrier. In the fog channels one sees the foliage and the luxuriant growths of a humid clime: the closed cañons look dry and have drought resisting or short-lived plants except close to the streams, many of which run only for a short time after the rainy season ends. The redwood and the California nutmeg (*Torreya californica*) may be taken as types of the two localities. The difference is due to water.

In parts of the world where, over great areas, conditions are similar, and the water supply is regularly much above the minimum requirement, the dependence of plants and animals upon water is much less clear, the influence of water upon them much less evident. There can be no

greater contrast in appearance, size, texture and behavior, than is offered by the two commonest and most characteristic weeds of the two seasons, the two climates, of this region, namely miner's lettuce (*Montia perfoliata*) and tar-weed (*Hemizonia luzulaefolia*).

Miner's lettuce, so named because used in the early gold-mining days of California as a salad, grows in the rainy season, when the temperature is low, often below freezing at night, the humidity high, and the soil wet and soft. Its tender, fleshy, but not thick leaves forming a cup upon a succulent stem which is carried on small and shallow roots, are traversed by slender and simple vascular bundles, and the supporting tissues are slight and weak. Its growth is directly proportional to the available and retainable moisture, for it can hold little water against dry air. In a season of scanty rainfall miner's lettuce is short and small, presenting almost a wizened appearance, and as the dry season comes on it droops, dries and disappears.

Tar-weed, so-called because of the odor of the secretion from the glandular hairs borne on its small dry leaves and the slender woody stem and branches, is a well-rooted summer weed, occupying the grain-fields after the crop is harvested or continuing long after the native grasses are dry and dead in the caked soil, growing and blooming till the rains come to soften it and to start its successors. It reaches its best development in dry and solid soil, dry air and daily sunshine. Its consumption of water is probably not less than that of miner's lettuce, but its roots can get water and the rest of its body can hold it, in soil and air so dry that miner's lettuce would shrivel and die. Or, to express a more general truth, water determines the character of the vegetation of the succeeding seasons.

Between the plants of the desert and those growing in the spray of a waterfall one may find all gradations, not only within the limits of the state, but often within the limits of an afternoon's walk. Can one do the like elsewhere on this continent or in Europe?

From a study of these conditions there should come clarity to our conceptions of the relations of water and plants, and ultimately such an extension of our knowledge of these relations as will lead not only to clarity, but to completeness.

Water, as a clear and liquid mass, or very finely divided and greatly diluted by the air, we regard as nearly perfectly transparent, though we know that even the clearest water permits the penetration of light for only comparatively short distances beneath the surface. Cloud and fog, less finely divided water than that which we record as the humidity of the air, are far from translucent. We are beginning, as a result of studies of light in very dry air, to suspect that we have underestimated the influence of water upon the quality and the amount of light available for plants in food-manufacture and acting upon them as a stimulus to

other activities. If an effort were made, I have no doubt that a very considerable list might be made of plants known to bloom and to fruit only scantily and rarely elsewhere which fruit regularly under the stimulus of the richer and more abundant light which penetrates the dryer atmosphere of the Pacific coast. Liverworts and mosses, "shade-loving" here as elsewhere, fruit abundantly and regularly, but it should be stated that their spores do not always reach perfection because there may not be time enough between the cessation of the rains and the beginning of the really dry season for them to mature fully. But, given the necessary minimum of water in soil and air, plants will fruit, crops will come, the more abundantly the more light of suitable composition they receive. And we shall presently see that the rays of the upper half of the spectrum, the violet and the ultra-violet, the ones most absorbed by water and water vapor, whether visible or not, are the ones most stimulating to bloom and fruit. Soil fertility, light fertility, and water—these three—and the greatest of these is water.

SOCIAL LEGISLATION ON THE PACIFIC COAST

By Professor WILLIAM F. OGBURN

THE Pacific coast states represent a future empire. Nature has marked them off by natural barriers and by climate more distinctly than any other division of the United States. This fact so impressed the distinguished author of the "American Commonwealth" that he speculated upon the development of a Pacific coast type of the human race and pointed out that this region might quite naturally have been the home of a separate nation. Oregon, Washington and California are equivalent in area to France and the British Isles. Their population, however, is only four and a half million, while the population of France and the British Isles is eighty-five million. It can not safely be predicted that these far western states will ultimately hold so dense a population as these European nations; yet, undoubtedly, the future will see an immense population dwelling in these new states. The opening of the Panama Canal has most dramatically forced this fact on the attention of present inhabitants of the Pacific Coast.

Here, then, an empire is being built. To the student of science it suggests several questions. How can a state be scientifically built? What principles do the researches of political science yield? Should state-makers use the experimental method? Will a democracy, in which the common people rule, be sufficiently far-sighted and capable to utilize scientific principles in building their future state? These questions arise when one studies the experiences of the Pacific coast states in state-making. It is the purpose of this paper to present the beginings of empire-building in Washington, Oregon and California as seen through their treatment of social problems. Before such a presentation is made, the viewpoints suggested by these questions need some elaboration.

The first question is: How does political science say a state should be scientifically built? Can a state be built as scientifically as an engineer spans the East River with a suspension bridge? Political science is not as exact a science as engineering, yet it has developed sufficiently to speak definitely about the making of states. The contributions of this science to state-craft may be referred to as the theory of the state.

At the time of the declaration of independence by the American colonies, the theory of the state held that the government which governed least governed best. Organized government as then known in Europe had been achieved primarily by the strong man, as typified by

the monarch. The monarch had served the very useful purpose of welding heterogenous tribes into a more or less unified whole. Through several centuries of this type of nation-making the peoples finally broke their customs of faction and their tribal habits. They became accustomed to living in the larger nation under a common language and a common law. This type of the strong man's work was then done. Under the changed circumstances his functioning appeared to the governed as tyrannical. The idea of political liberty grew. Liberty and government seemed to form a paradox. And that government which governed least was believed to govern best.

With a government owned by the people, tyranny and government ceased to be the same thing. Government and liberty were no longer incompatible. But the idea persisted, as is usual in social evolution, long after the conditions which produced the idea had changed. It persisted perhaps somewhat longer in the United States than elsewhere because of the strong individualism developed by a nation of pioneers, conquering the wilderness in small groups with little aid from the government.

Government now appears as collective organized effort. Individuals can do little acting singly, but acting through collective organized effort undreamed-of achievements may be made. The world has hardly begun to see the possibilities of organization. Hence more government is desired. This is particularly true in modern society with its tremendous complexity and heterogeneity. This is the conception of the state from the point of view of government. How is it from the point of view of the individual and liberty? The older notions of liberty meant freedom from an overbearing government, freedom to pursue life, liberty and happiness, and especially to own property. Several years of this unrestrained liberty have resulted in liberty for some, but not for others. The socially strong and the lucky have been successful, but with their success the liberties of the socially weak and the unlucky have fared very badly. The liberties of many must therefore be protected by the government. This is what is meant by the term "social justice." Furthermore, with the conception of government as the collective organized effort of all the people, the idea of "the common good" is being emphasized more than "individual rights" and the term "social freedom" is replacing the term "liberty." Therefore, from the point of view of government and of liberty an extension of governmental functions is desired. And the advice of political science on state-building is that modern society demands a government developed beyond the narrow limits of the past to the aims of social justice and collective effort. It will be interesting to observe the developments on the Pacific coast under the light of this new theory of the state.

Perhaps the reader will argue that this new theory is, after all, only

a theory and is far from being a law of an exact science. In that case if the new states build on this new theory they will be experimenting—a method which has the high approval of science. It has often been maintained that the experimental method will forever be denied the sociologist. For how can a sociologist experiment with democracy, as, for instance, a physicist experiments in his laboratory with rays of light? It would indeed be a strange discovery, if it were found that the peoples of the Pacific coast showed a willingness to experiment with their governments and were actually doing so.

With some thinkers it is still an open question whether democracy will live. Therefore it may seem absurd to discuss the ability of the common people to build a state scientifically. Empire-builders have formerly been men like Cæsar, Napoleon, Bismarck. Can the plain citizen do it? If they can, it means that the masses must not only become aware of scientific progress, but must often be willing to look beyond present needs and strong desires to the far-removed good of a future goal. The first requirement is that they shall benefit from mistakes of the past, as, for instance, the mistakes in the building of the United States. The development of the great American republic has been remarkable, but it has been accomplished at an enormous cost. Natural resources have not been conserved. Social good has been sacrificed for individual gain. And the people are now looking back with regret at the destroyed forests, at the lost water rights, and at the enthronement of special privilege. They see large numbers of their fellow-citizens struggling against an inadequate standard of living and weighted down with poverty and ill-health and unemployment. Will the Pacific coast states benefit by the experience of the United States?

The preceding paragraphs suggest the interpretation of the social order on the Pacific coast as presented in this paper. This social order is both distinctive and novel. To see it is important because it may be a glimpse into the future of forty-five other states. The following pages will present aspects of it as seen through legislative enactments, excellent indexes of the organized efforts of its citizens. For this purpose the social legislation will be classified into four groups: changes in the form of government, labor legislation, legislation affecting women and general welfare legislation.

In governmental changes Oregon is the leader. Her priority in large governmental adaptation has given rise to the term, the Oregon system. And by the Oregon system is meant such a body of laws as the initiative and referendum, the direct primary, the direct election of senators, the recall, the corrupt practices act and the presidential preference primary. Associated with these are woman suffrage, home rule for cities and a constitutional amendment making it possible to adopt proportional representation. The Oregon system sprang from

the corruption of the nineties. The people were dissatisfied with their state legislature, and with cause. They decided to make some of the laws themselves and to have the right of rejecting any of the legislature's enactments which they chose. The initiative and referendum, making these achievements possible, were adopted in 1902. South Dakota and Utah had previously passed constitutional amendments making the initiative and referendum possible, but seem to have made little use of them. California began popular lawmaking in 1911, and Washington in 1912. Following Oregon's example, there are now nineteen states that practise direct legislation.

Oregon citizens have voted in seven elections, extending over a dozen years, on one hundred and thirty-six measures, adopting fifty-one and rejecting eighty-five. The fifty measures adopted include all the above mentioned laws of the Oregon system and, in addition, prohibition, employer's liability, three-fourths verdict in civil cases, eight hour law on public works, and the abolition of capital punishment.

All the laws so far mentioned were proposed by the people themselves through the initiative and not by the state legislature, as indeed are nearly all the measures which are voted on by the people. Among the eighty-five measures rejected are a state income tax, several single tax measures, measures making it possible to abandon the general property tax, prohibition, woman suffrage, eight hour law for women, universal eight hour law, measures providing wholesale changes in the state constitution, proportional representation, and the abolition of the senate.

Some results[1] of Oregon's experiment in direct legislation are the following. A body of excellent laws have been passed with surprisingly few mistakes. Some good measures have been defeated—also several radical measures and a number of measures of minor importance. The people are conservative as well as progressive. For the education of voters the initiative and referendum are unsurpassed. The voters take a good deal of interest in lawmaking, watching the ballot carefully for jokers and private motives. Seventy-five per cent. of those who vote, vote on the measures. All classes of citizens initiate laws. The voters amend their constitution as readily as they pass bills. The tendency is to place a larger number of measures on the ballot. The efficiency of representative legislatures seems not to have suffered, but perhaps to have gained.

The first law passed by the initiative in Oregon was the direct primary law. The direct primary, by permitting voters to vote directly for nominations, has done more than any other device to break the grip of

[1] The evidence for the above mentioned conclusions may be found in the following papers: Ogburn, "Direct Legislation in Oregon," Quarterly Publications of the American Statistical Association, June, 1914; and Montague, "The Oregon System at Work," *National Municipal Review*, April, 1914.

machine politics and to restore control to the people. Oregon was the second state to adopt the direct primary; Wisconsin, in 1903, preceded Oregon by one year. Washington followed in 1907 and California in 1909. Now there are thirty-two states possessing it, not counting the southern states that have long had the white primary. The effect of direct nominations has been to loosen party ties. Perhaps other governmental agencies have assisted, but at any rate, party ties bind very lightly on the Pacific coast. Some careful observers think that the direct primary has finished its work in Oregon and that it has left an expensive and troublesome double elective system. Hence Portland, Oregon, is found by 1913 adopting a non-party preferential system of voting that necessitates only one election and provides approximately majority rule by the counting of second and third choice votes. Washington also has a preferential system for state elections. The system is somewhat technical, but seems to have produced excellent results in the few elections in which it has been tried.

In the Oregon direct-primary law was found a curious clause known as "Statement No. 1." The operation of "Statement No. 1" resulted in the direct election of United States senators without the adoption of a constitutional amendment to that effect. "Statement No. 1" was simply a statement, which might or might not be made by a candidate for the state legislature, to the effect that he would vote in the state legislature for the people's choice for United States senator. The candidate felt that his chances of election were better if he thus pledged himself. Although a majority of the candidates "took" the statement, the fight to make it effective was dramatic. It was so successful, however, that a republican legislature was forced to elect a democrat for senator. Attention is called to "Statement No. 1" because it was a genuine invention, the rarest of phenomena in politics. Other states followed Oregon's example. All such devices lost their force, however, when the constitution of the United States was so amended that senators are no longer elected by the state legislatures, but directly by the people.

Associated in spirit with the initiative and referendum is the recall of public officials at the will of the voters before the expiration of their terms. Oregon adopted the recall in 1908, and was the first state to do so. California followed in 1911 and Washington in 1912. At the present time ten other states have the recall. The recall has precipitated much argument concerning the whims of democracy and mob psychology. However, experience shows that it has not been used very much. The most conspicuous cases are the recalls of a mayor and an occasional councilman. The failure to use it is not due to the number of signatures necessary to put it in operation, but rather to the difficulty in securing an able candidate to run against the recalled official and

the fear on the part of the recallers of the wrath of the electorate at the expense of another election. An interesting and much-discussed feature is the recall of judges. Oregon and California permit the recall of judges; but they do not seem disposed to recall them.

In the field of local government the cities have home rule. Formerly the treatment of many strictly city problems was ordered by a state legislature many miles away and composed largely of representatives from rural districts. This led inevitably to the infusion of state and national party issues into city affairs, where they obviously had no place, and to the development of "the systems," manipulations and patronage. The commission form of government is found in large cities in the three states and there is the local initiative, referendum and recall. One may also see here an example in one of the smaller towns of the city manager plan.

Several changes in governmental procedure have been suggested. Prominent is budget procedure. California, through its state board of control, has taken the lead in budget-making. In 1913 two weeks before the state legislature convened a scientific budget was presented which resulted in a saving, it is claimed, of over $2,000,000. Other states have followed and proposals of budget reform are being made in Washington and Oregon. A consolidation of the various state boards and commissions and a reorganization of the administrative departments on the model of the United States cabinet has been widely favored in Oregon and is expected soon. The program also calls for the short ballot. Oregon has voted, though unsuccessfully, for proportional representation, the abolition of the senate and a union of the legislature and the executive. The future of these latter proposals is uncertain. The record of Oregon, California and Washington in governmental changes has been one of brilliant experiment.

The greatest extension of the functions of government for social freedom is in legislation affecting the wage-earner. Policies of liberty and of individualism have not meant liberty and individuality for the wage-earner. He has been unprotected. He has borne the toll of hazard in industry and often accommodated himself to a standard of living that is far from meeting the requirements of a democracy. The field of labor is the scene of the struggle for social justice. The labor problem and the status of industry are intimately related. Industry in the west has not reached the large development of the eastern states. Hence large and acute labor situations have not given rise in the west to so urgent a need of labor legislation. Furthermore, the Pacific coast is very eager for capital to seek industrial investment within its domains. But labor legislation may raise the cost of production as compared with the competitive industry of other states. Hence care would seem necessary lest industrial development be discouraged. But should

industry be purchased at the cost of the welfare of the workers? This is the problem that often confronts the voter. How have the Pacific coast states met this dilemma?

The first modern labor laws protecting the wage-earner were those dealing with child labor. California was one of the first states to provide child-labor legislation. Such legislation was passed in 1889, amended in 1901 and greatly improved in 1907. Washington and Oregon passed excellent laws in 1903. There have been further amendments so that the laws in these three states have a general age-limit of fourteen years, prohibitions of night-work by children, compulsory school attendance and highly important provisions for adequate enforcement. Suggested improvements are to raise the general age-limits and to provide a broader foundation of education through a longer period of compulsory school attendance.

Society is very much interested in the labor laws known as employer's liability and workmen's compensation. Modern industry bears only a slight resemblance to the craft and the rural work dealt with by the common law. Modern industry is a huge machine for which there must be workmen. Every year men, like machinery, are cast on the scrap heap. Under the common law there is no adequate financial aid for widow and children or for a dragged-out life as a cripple. California, Washington and Oregon early developed laws making employers financially liable by recourse to the courts to the employees for accidents. But the courts were slow and strange to the workmen; lawyers were expensive, and a thriving insurance consumed funds. Hence workmen's compensation laws making payments definite and automatic were passed. California passed a workmen's compensation law in 1911, being the fifth state to put it into effect. Washington passed a similar law the same year, and Oregon also in 1913. At the close of 1914 there are twenty-four states thus protecting workmen. Washington and California compel employers to operate under the law, while Oregon's law is elective, the alternative being employer's liability.

Of equal consequence to workmen are occupational diseases, such as anthrax, compressed-air illness and lead poisoning. California in 1911 was the second state to put into effect a law requiring the reporting of occupational diseases, and her law has served as a model for many of the fifteen other states which now make such requirements.

Labor has also been attacking its problems without the aid of legislation, namely, through the labor union. The methods of unions have been severely criticized, perhaps more than their aims. This is to be expected because labor is on the firing line of conflict, that has for its stakes bread and butter and housing. The daily labor of workmen is rough, direct and concrete; the efforts of their organization are of the same nature. The Pacific coast has had its share of labor-union activities.

But experience shows that the more completely organized labor is, the less its violence. This is shown by the experience of England, of the excellently organized trainmen and the ill-organized I. W. W. The skilled labor on the Pacific Coast is now well-organized as compared to other states. And in Seattle, Portland, and San Francisco, organized labor is a strong force. Figures from the Bureau of Labor Statistics at Washington, D. C., show that in general organized labor draws slightly higher wages and works slightly shorter hours here than elsewhere. Similarly, the laws are favorable to organized labor.

The conditions of the unskilled and the unorganized laborers are not so favorable on the Pacific coast. This is partly due to the nature of some of the main industries such as lumbering, wheat harvesting, the raising of fruit and hops, and construction work. These industries are seasonal to a high degree and the jobs last only a short while. This means that the living conditions are of the roughest sort. As the distances are great, the laborers are peculiarly migratory. The railroad tracks are their highways and one may here see at almost any time these migratory workers walking the railroad ties, and always with blankets rolled in bundles on their backs. The blanket pictures symbolically their crude home conditions and social life. These conditions breed the I. W. W. Here is a great need for the state to extend its functions to bring a real liberty and tolerable living conditions. Much depends on the possible success of these unskilled migratory workers in organizing. So far there has been little success. Calilfornia has recently made an investigation of labor camps and has enforced better living conditions. The free public employment bureau thoroughly developed and publicly controlled would greatly help the situation. The private employment agencies of the present time are greatly criticized with reference to their private nature, the number of them, their fees, their relation to employers. What is needed is an organized labor-market with adequate machinery for finding jobs and filling vacancies. Many of the cities have free employment bureaus; but, comparatively, they are small in number, and have not been able to compete successfully with the private agencies. California has a law, in effect in 1913, which regulates the private agencies by license and bond and by returning fees under certain conditions. The situation was so bad in Washington that the people voted at the 1914 election to abolish altogether the private agencies; the measure adopted did not even provide for public bureaus. A measure providing for labor exchanges is being prepared for the Oregon legislature meeting in 1915.

The great industries of the Pacific coast are highly seasonal and there is very little dove-tailing of them. This means that in the winter months there are large numbers of unemployed. Their numbers by industries are given in the federal census. They leave their summer

camps and flock to the cities, the centers of employment bureaus. In years of business depression the unskilled worker is caught unexpectedly, as indeed is industry. In such times, large numbers of the unemployed are utterly destitute. The winters of 1913 and 1914 were times of such experience. Some relief in shelter and food was provided by the cities; also a little work which was in the nature of relief was furnished. This was done through the city and county officials and through the collective effort of the aroused civic organizations. Unemployment is a problem as difficult to solve as it is grave. The first step in diminishing unemployment is to provide an adequate system of public employment agencies. This will probably accomplish more in reducing unemployment than is commonly supposed. Another proposal is to hold over city, county and state work until the unemployed season. In the northwest there is movement to employ the unemployed at clearing land. In this region there are large areas of stump-land. If the state would furnish cheap credit to the farmer both the rural situation and the unemployed would be benefited. California has recently appointed a commission to study the causes and effects of unemployment and to report.

A number of other labor conditions have received the attention of the legislators. In the three states, labor in mines is limited to eight hours and the hours of labor on railroads are carefully regulated. They also have the eight-hour day on public works as, indeed, have twenty-three other states. Oregon has a ten-hour law for men in mills and factories. California has an important law providing one day's rest in seven. This has been on the statute books since 1893 but only recently has much attention been paid to its enforcement. The most important single general feature of labor laws is the enforcement provisions. Enforcement is being stressed more and more by the increasingly important labor bureaus of the three states, particularly in regard to the inspection of factories for unsanitary conditions and for unguarded machinery. California's Bureau of Labor Statistics has recently been very active. The hours of labor permitted women in industry are definitely restricted; this feature will be discussed in a later paragraph. The subject of old-age pensions has been little discussed. The present-day worker tends to become unfit for the pace of modern industry at a comparatively early age, at a time of life when the professional man is only reaching maturity. This forces the issue of old-age pensions. California in 1913 appointed a commission of five to investigate and report on old-age pensions. Massachusetts and Wisconsin have similar commissions.

This summary of labor legislation shows that the Pacific coast states have advanced labor legislation to a degree quite comparable with that of their governmental reforms. This policy has not been wholly approved.

The strongest criticism is concerned with the welfare of business. Business in one state may suffer from competition with business in another state if laws which affect the cost of production are unequal in the two states. Charges of this nature have been made in the Pacific coast states with reference to some businesses. It is to be observed, however, that labor legislation is rapidly spreading, thus reducing the evils of competition and lack of uniformity. For instance, in a very few years, workmen's compensation laws have spread to twenty-four states. Indeed the rapid spread of social legislation is one of the incidental demonstrations of this paper.

Of all classes of wage-earners, women most need protection. They have not learned to organize for better wages and shorter hours, and there are special obstacles to their doing so. Yet, the inroads of machinery into the home-occupations are throwing large numbers of inexperienced women into the factory and the store, a situation not suited to a policy of little government and unrestrained liberty. And when it is remembered that women are peculiarly related to the welfare of the race, the new theory of the state seems amply warranted in legislating for their welfare. The new states of the Pacific coast, in moulding their social order, have not hesitated to provide for their women citizens.

Oregon was the first state to limit extensively the hours of labor for women; in 1907, a ten-hour law was adopted. Maine and North Dakota had previously passed ten-hour laws for women, but these were for a rather limited field of occupations. Oregon's ten-hour law is famous in being the first to be declared constitutional by the supreme court of the United States. California and Washington, in 1911, adopted eight hour laws for women and remained unique in this respect until 1913, when eight-hour laws were passed in Arizona and Colorado. In 1914, a similar law was given the District of Columbia. The hours of labor of women in Oregon have been further restricted under the minimum wage law for women. This law gives the commission establishing the minimum wage the power to limit hours of labor. This has been done varyingly for the different industries.

Of recent labor legislation for women, the minimum wage laws have aroused the greatest interest. The causes necessitating the minimum wages for women are mainly these. The development of the factory and the consequent break down of home industry has forced large numbers of women to seek employment outside the home; and the large supply of women means a low wage. The supply has been unevenly distributed because of the attractions of the store and the unattractiveness of the domestic work in the private home. The situation has been further aggravated by the fact that some girls who could be partially supported by parents were willing to work at very low wages. These

marginal girls thus forced down the wages of others who were not partially supported at home. Facts showing these conditions in Oregon were determined by an investigation conducted by the Oregon branch of the consumer's league. The report claimed that "nearly three fifths of the women employed in industries in Portland receive less than $10.00 a week, which is the minimum weekly wage that ought to be offered to any self-supporting woman wage-earner in this city." Accordingly, in 1913, the Oregon Legislature passed a minimum-wage law, being the second state to do so. The law was the first, however, to be put into effect. Massachusetts had previously adopted a minimum-wage law in 1912, but was slower in putting it into effect. Oregon's law further differed from Massachusetts's in providing a penalty of a fine or prison sentence for violations. Oregon's law served as a model for the California and Washington legislatures of 1913. Nine states now have minimum wage laws for women.

The minimum wage laws of the Pacific coast states create industrial welfare commissions with the power of setting minimum wages for women. These wages are recommended by conferences called by the commission and composed of employers and employees of the particular industry and of the public, each equally represented. The wage is legally set, however, only after a public hearing. As a result of rulings by the industrial welfare commission, the employers of industry now pay all women wage-earners in Oregon at least $8.25 a week. In Portland, the only large city in Oregon, the minimum wage is $8.64 a week in manufacturing establishments and $9.25 in offices and mercantile houses. Apprentices may work at $6.00 a week. In Washington, the minimum wage has been set at $8.90 in manufacturing establishments, $10.00 in stores, and $9.00 in telephone and telegraph offices and in laundries. The Washington apprenticeship ruling is somewhat better in that it limits the number of apprentices and the length of time of apprenticeship. The variation in the minimum wages is due to the theory that the wage should be a living wage. As to the effect of the minimum wage on business, the worker and society, no official reports or investigations have been published, although such reports are expected in a few months from the industrial welfare commissions and from the national bureau of labor statistics. However, the mercantile employers of Portland in the summer of 1914 testified before the federal industrial relations commission: (1) that the number of employees whose wages were increased was twenty-two per cent. of the total number of female employees, and that the amount of such increase in relation to the total payroll of both men and women was two per cent.; (2) that "as nearly as could be ascertained, no employees were discharged"; and (3) that the general effect on business was "negligible." Perhaps the strongest criticism of this testimony being typ-

ical would relate to the number of employees discharged. In Oregon there have been a score or more of prosecutions.

The welfare of the race and of women is further protected by mothers' pension laws. These laws provide that a woman with young children whose husband is dead or incapacitated shall receive compensation if she or her children are dependent on her for support. This is a protection for the disintegrating home of modern industrial society and a protection for the children from the same influences that have necessitated the juvenile court. California, Oregon and Washington adopted such protective measures in 1913. Prior to 1913 only two states, Colorado and Illinois, had mothers' pension laws. Now they are found in nineteen states.

The most widely admitted injustice to women is connected with prostitution, especially in its commercial aspects. Recent years have seen a nation-wide vice fight. On the Pacific coast the fight has been made, particularly in the cities, through vice commissions and reform administrations; Seattle, Portland and Los Angeles being notable cases. Portland has adopted what is known as the tin-plate ordinance which provides that the name of the owner of every rooming house, apartment and hotel must be placed conspicuously on the front of the building. The purpose of the tin-plate ordinance is to fix responsibility on the owners of the buildings. Cases are known where property which ordinarily rents from $40 to $100 a month brings a return of $350 a month when used for purposes of prostitution. The fact is on record that one piece of property in San Francisco costing $8,000 brought in $2,100 a week. The attack has mainly centered on the commercialized nature of the social evil. The unfortunate prostitute has thus yielded a large part of her earnings to the landlord, the lessee, or in some cases the organization which more or less controls her. Or she is prosecuted in the courts, and must pay a fine perhaps over and over again. The sinister aspect of the situation is that some one other than the prostitute reaps these dearly-paid-for earnings and escapes, while added suffering is meted to her. This situation explains the origin of the so-called red-light abatement laws. The abatement laws permit a judge to close any building that is used for purposes of prostitution. The building, may be opened again by giving a bond equal to the value of the building with the pledge not to allow prostitution within the building. Washington, Oregon and California have abatement laws, modeled on the recent Iowa law. The age of consent in each of these three states is eighteen years. As a result of the recent experience of the Pacific coast states, some headway has been made in fighting the sinister commercialization of prostitution.

The woman's movement in its political aspects is well developed in the west. Women may now vote in each of the three Pacific coast states.

Washington thus extended the franchise in 1910; California, in 1911; and Oregon, in 1912. Previous to 1910, four western states, Wyoming, Colorado, Utah and Idaho, had permitted women to vote. Now twelve states have extended the franchise to women. The results of this extension of the suffrage are naturally of great interest. Some statistics of the number of women voting have been collected in different places. The relative proportions of women voting to men voting vary. Taking into consideration the fact that there are more men eligible to vote than women, an approximate average would show that about three quarters as many women as men vote. Women's organizations are showing increased interest in political questions. Political speakers often find that women constitute more than half their audience. Coincident with the voting of women is the prominence given to moral issues. Prohibition and the abolition of capital punishment were voted at the 1914 election in Oregon, these measures having been previously defeated at a recent election in which only men voted. This does not prove that women carried these measures, yet the general opinion seems to favor this conclusion. Recent reform administrations in Portland and Seattle have been attributed partly to the influence of women voters. There is also evidence which points to the influence of women in bringing health and educational measures to the fore. Two members of the Oregon state legislature in 1915 are women.

There remains to be considered legislation which does not concern directly instruments of government, or laborers or women as classes; this may be called welfare legislation. This class includes such topics as taxation, public utilities, prisons, education, eugenics, the sale of liquor and immigration.

The system of revenue in nearly all the states is the general property tax. The verdict of political economists is that it is unjust and antiquated; unjust because intangible personality escapes taxation, and antiquated because adapted to the relatively simple condition of a more equal distribution of wealth found in newer communities. The general property tax is supplemented by other forms of revenue, as inheritance taxes, corporation taxes and licenses, so that some states, perhaps not more than ten, have escaped much of the evil resulting from the general property tax. Fewer than this number of states have definitely abandoned it, having separated state and local taxation. California abandoned the general property tax in 1910 and acquired the separation of state and local revenues. Oregon has on two occasions voted against proposals leading to the abandonment of the general property tax. Every election for the last few years in Oregon has brought forth a good-sized list of tax measures to be voted on; and not many of them pass. Intense interest in Oregon has centered on the single tax. The single tax as discussed in Oregon means the raising of larger proportions of revenue from land and smaller proportions from improve-

ments and industry. The single-taxers claim that the increasing values of land are made by the community and that the community should take these values through taxation. They furthermore consider the taxation of industry as a hindrance to industrial development and unjust. The single-tax measures have assumed various forms, according to the imagined taste of the voters. Three times they have been voted down; though the election returns show that they were favored by about one third of the voters of Oregon.

Street railways are the public highways of the modern city dweller, as are the streets for the inhabitant of a small town. Hence the opposition to their use for private profit and the insistence on their regulation for the welfare of the citizens who have no other recourse than to use them. The public's interest in these public utilities is further heightened by the close relationship that has existed between the governments of the cities and the officers of the public utility companies. This relationship is quite natural, but in some cases it has not worked for the best interests of the public. Hence another governmental function has been developed, that of regulating public utilities. California, Oregon and Washington in 1911 passed public utility acts modeled on the Wisconsin law, placing the control and regulation with the state railroad commission. There are a few instances of municipal ownership of street railways on the Pacific coast. Seattle began the operation of a short line in 1914. San Francisco affords the more important instance, being the first large city in the United States to own and operate a municipal street railway. The Geary Street Railway began operation as a municipal road in December, 1912, after a long fight begun in 1896. The line is five and one half miles long. Its operation has been successful and the citizens seem pleased with it. A municipally owned railway is also being run to the fair grounds of the Panama-Pacific Exposition.

In the cleaning up of prisons and the bettering of conditions of prison labor, the Pacific coast states have taken a leading place. The theory of prison reform is to turn prisoners back to society better men and women. To this end the "honor system" has developed. This means that prisoners are permitted to work at their various occupations with no armed guard, bound only by their pledge of honor. Published reports state that there are no more escapes than under the old system. The "honor system" has been developed in Nevada, Colorado and in a few prisons in Ohio and in New York; but Oregon is notable in having proportionately more prisoners working without guard. The "honor system" is more spectacular, but no more important than other features of prison reform, such as farm colonies, treatment of female prisoners, medical aid, manual training shops and the parole system. Progress in these features has been especially marked in California during the last three years. The private leasing of convicts by contract and the

inhuman situation which often develops therefrom have been prohibited in Washington, Oregon and California. Washington and Oregon in 1912 and in 1914, respectively, abolished the death penalty.

It was long ago realized that public schools are foundation stones of efficient democracy. Their maintenace was one of the first extensions of the government's functions. All the states now have them. The modern social movement is concerned with perfecting the already accepted system. The efficiency of the public school systems of the forty-eight states was recently investigated by the Russell Sage Foundation and a comparative study published in 1912. The measurements of efficiency were based on the following features; children in school, school plant, expense per child, school days per child, school year, attendance, expenditure and wealth, daily cost, high schools, salaries. Ranked according to these standards, Washington stood first of all the states, California fourth and Oregon fifteenth. California and Washington furnish free text-books to the public school children.

In the new science of eugenics, California is one of six states to require the sterilization of such unfit as the confirmed criminals, insane and feeble-minded, who are in institutions. Unfortunately, there are only a few of the feeble-minded confined to institutions. The Oregon legislature passed in 1913 a sterilization measure which was, however, referred to the people and defeated. The sterilization laws are similar to the Indiana law, which provides for a rather novel and simple operation which prevents the conception of offspring and thus safeguards society against the transmission of socially undesirable hereditary traits. These laws have sometimes fared badly with the courts and the changing governors. Oregon requires that the applicant for a marriage license shall present a certificate from a physician stating that he is free from venereal disease.

Oregon and Washington in 1914 voted in favor of prohibiting the sale and manufacture of liquor, making the total number of prohibition states fourteen. In the same year California voted on prohibition, but the measure failed to carry. California, however, has local option.

Immigration is a very serious matter for the Pacific coast states at the present time. Yet little has been done to receive the possibly large number of immigrants who may come and to prevent them from breaking wage scales, from congesting the cities and from developing bad housing conditions. The trade unions of the Pacific coast have held a convention on the subject. The most important step has been taken by California in creating a commission on immigration and housing, with a paid secretary and an annual budget. This commission has made a survey showing the status of housing, the living conditions of labor camps, and the methods of the various exploiters of immigrants. As a result of this survey, it is recommended that the state tenement house Act of 1911 be more strictly enforced, that the commission be given the

power to license lodging houses used by immigrants, and that health and sanitation rules be more strictly enforced in the labor camps.

In making this brief survey of the experience of the Pacific coast states in state-building, the author has no doubt omitted several important features. Such omissions, with the exception of two, have been made because it was thought best to include only those features in which the Pacific coast states were somewhat distinctive. The two omissions just referred to are the rural problem and the development of business. These are important, but are without the limits of this paper.

The conclusions of this paper show that in empire-building citizens of a democracy have not hesitated to build according to the new theory of the state as set forth by the researches of political science, a theory that demands a government strongly and widely developed for the aims of social justice and collective effort. These new states have shown efficiency and built with dispatch. Government as collective organization and effort has been excellently demonstrated. The unrestrained liberty which has meant injustice to others or to the group has in many ways been restrained, and the forgotten rights of the unprotected have not been neglected. The new states have not hesitated to experiment. It is well to see these experiments in summary. Oregon was the first state to adopt the recall, the direct election of senators, the presidential preference primary, to pass an extensive ten-hour law for women and to put into effect the minimum wage law for women. California and Washington were first to adopt the eight-hour law for women. California was the first state in scientific budget making. Washington was first to abolish private employment bureaus and is first in the efficiency of public schools. Oregon was third to provide for the initiative and the referendum and was first to develop them. Oregon was second to adopt the direct primary and California was second to put into effect a law requiring the reporting of industrial diseases. There were only two states to precede the Pacific coast states in creating mothers' pensions. In adopting other social legislation, while not the first, second or third states, Washington, Oregon and California were in a small leading group to legislate effectively on home rule for cities, child labor, hours of labor on public works, factory sanitation and inspection, employer's liability, eugenics, prohibition, prison reform, public utilities, municipal ownership, the social evil and woman suffrage. The success of these experiments may be interpreted by observing the extent to which other states are following their example. To see the new social order of the Pacific coast, social legislation should be looked at in its entirety. This social order is distinctive. No other group of states possesses such a wealth of social legislation. This paper has aggregated the variety of cases found among these Pacific coast states and it is a very imposing picture that is revealed.

THE VOLCANIC ACTIVITY OF LASSEN PEAK, CALIFORNIA

By Professor RUFUS S. HOLWAY

NOTWITHSTANDING vague reports of early settlers it now seems practically certain that no white man had witnessed an eruption of a volcano within the limits of California until May 30, 1914. On that day Lassen Peak, a well-known old volcanic cone in the northern part of the state situated about seventy-five miles southeasterly from Mt. Shasta, suddenly burst into explosive action. During the six months that have elapsed since the first eruption took place, including one quiescent period of twenty-three days, there has been an average of one eruption every three days with no indication at the time of writing that the activity has ceased. The uniqueness of the phenomena as part of the physiographic processes of the United States[1] invites some detailed description for several reasons.

A natural curiosity exists concerning the events which have actually occurred and also as to the most probable developments in the future. Is this recent activity a sign of the rejuvenation of a long quiescent volcano which is once more to pour forth its floods of lava? Or are the outbursts merely the last relatively feeble, but convulsive efforts preceding the final extinction of the subterranean forces that formerly built up the old lava cone still after centuries of erosion towering nearly two miles above the level of the sea? As yet reliable forecasts of volcanic activity are not made on a scientific basis, but it is hoped that the following pages will at least give a satisfactory outline of the history of the region up to the present writing.

Lassen Peak stands in the southeastern part of Shasta County, nearly two hundred miles from San Francisco. According to the Lassen Peak topographic sheet (a reconnaissance map surveyed in 1882–84, see Fig. 1), the mountain is ten thousand four hundred and thirty-seven feet in elevation and is approximately in latitude 40° 30′ N. and longitude 121° 30′ W. The immediate region is the extreme southern portion of that great tertiary lava flow some two hundred and fifty thousand square miles in extent, covering not only northeastern California but portions of Oregon, Washington, Idaho and Nevada as well.

[1] Volcanic eruptions in Washington have been reported but apparently never studied at close range. Professor George Davidson reports seeing Mt. Baker in eruption in 1854 and in 1870. *Pacific Coast Pilot U. S. G. S., 1899.* J. C. Fremont in his journal under date November 13, 1843, writes as follows: "At this time two of the great snowy cones, Mount Regnier and St. Helens were in action. On the 23 of the preceding November, St. Helens had scattered its ashes, like a light fall of snow over the Dalles of the Columbia, 50 miles distant." *The Exploring Expedition. D. Appleton & Co., 1846.*

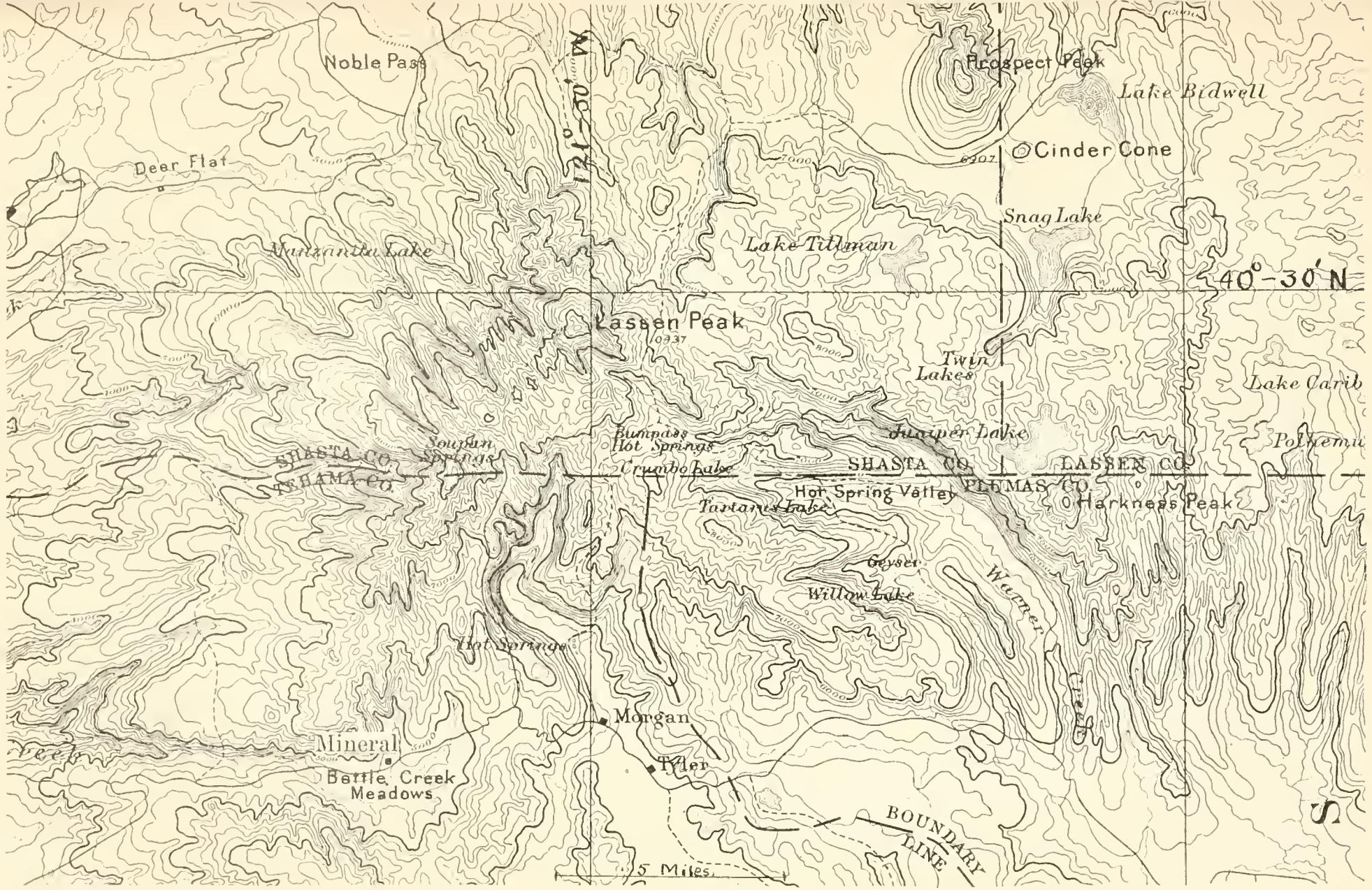


FIG. 1. LASSEN PEAK AND VICINITY. The area shown is the central portion of the Lassen Peak sheet of the U. S. Geological Survey. The quadrangle was surveyed in 1882-84. As reproduced here the scale is practically four miles to the inch.

In general, geographers consider Lassen Peak as marking approximately the southern end of the Cascade Range, and as being the last of that series of great volcanic cones of which Rainier, Adams, Hood, Three Sisters, Mazama, Pit and Shasta are familiar examples. To the southeast of Lassen the topographic gap of the Feather River separates the Cascade Range from its correlative, the Sierra Nevada, which extends four hundred miles farther to Tehachapi Pass, but whose lofty peaks owe their height primarily to uplift rather than to volcanic upbuilding.

The southern fifty miles of the Cascade Range extending northwesterly toward Shasta from the North Fork of the Feather River is a great volcanic ridge, about twenty-five miles wide. This ridge is studded with numerous minor volcanic cones culminating in Lassen, the dominating peak, which is guarded by a number of other major cones rising to heights varying from seven thousand to nine thousand feet above the sea. Past volcanic phenomena of the Lassen Peak region in recent geologic time have been made familiar to readers through J. S. Diller's well-known report,[2] which describes with considerable detail the Cinder Cone, ten miles northeasterly from the main peak, from the base of which the latest lava flow issued. Until the present outbreak, despite our knowledge of the Cinder Cone lava flows, it has been tacitly assumed in physiographic literature that Lassen Peak belonged to the class of extinct volcanoes, although the following statement by Diller in the folio just quoted shows clearly that twenty years ago he did not consider the volcano entirely extinct.

> The latest volcanic eruption in the Lassen Peak district, and possibly the latest in the United States south of Alaska, occured at the Cinder Cone about two hundred years ago. Some of the trees killed at the time are still standing. The lava, although very viscous, spread more than a mile from the vent and formed a huge tabular pile which extends across a little valley. The lava dam thus formed developed Snag Lake, which contained stumps of some of the trees drowned at the time the lake originated.
>
> That volcanic activity is not yet extinct in the Lassen Peak district is shown by the presence of numerous solfataras and hot springs. At Bumpass's Hell, near the southern base of the peak, there are boiling mud pools and vigorous, solfataric action. Near by, at the head of Mill Creek, the sulphur deposited by such action is so abundant that attempts have been made to mine it. Similar phenomena occur in Hot Springs Valley and at Lake Tartarus and the Geyser, near Willow Lake. The Geyser is much less vigorous than formerly, and now the column of water rises scarcely a foot above its pool.

Previous to the present activity of Lassen Peak there had been numerous indefinite reports of eruptions witnessed by the Indians in that vicinity shortly before the coming of the white settlers. The most definite of these reports is given in a recent letter from Dr. J. W. Hudson, of Ukiah, California.

[2] Lassen Peak Folio, U. S. Geol. Survey, 1894.

I was in that region in 1904 collecting for Field Museum of Natural History, Chicago, department anthropology, and heard much of Lassen Butte. An old Indian told me that when a child and living some sixteen miles northwest of Cinder Cone, there came an earthquake at Lassen one summer day. The sun arose, but gradually faded to the darkest night and ashes came down like a heavy snowfall. Its weight finally broke in the bark houses and the natives rushed out into the darkness. The boy was taken by a grandmother to a hollow pine log where they remained till nearly famished. When the sun reappeared he was carried many miles before drinkable water was found. I presumed at that time my informant was near seventy years old and about six on the above occasion, thus approximating the date 1850 for this eruption. In many localities along the Pit river water shed I heard similar reports amongst the aged Indians. The name of this volcano in Palainihan tongue is "Am blü'-kai" "Mountain ripped apart."

The region about Lassen Peak for many miles is very rugged, the few valleys suitable for agriculture lying at an elevation of from 5,000 to 7,000 feet. Naturally it is sparsely settled, and this year, on the date of the first eruption, the snow was still very deep, obscuring all roads and trails down to the six-thousand-foot level. On account of the unusually late season, the summer influx of cattlemen, lumbermen and campers had not yet begun; probably the nearest occupied house was at least eight miles distant from the mountain top.

Prompt investigation of the first eruption is due to the fortunate fact that the mountain is included in the Lassen Peak National Forest and that the United States Forest Service[3] had built a fire look-out station on the topmost crag of Lassen Peak itself. The summer headquarters of the forest supervisor, Mr. W. J. Rushing, are in Battle Creek Meadows, near Mineral postoffice, a little more than ten miles in an air line from the top of the mountain. The look-out house on Lassen and the other stations also are connected with the supervisor's headquarters by the government telephone lines which extend to the town of Red Bluff, nearly fifty miles to the westward, giving direct communication with San Francisco. When the eruptions began the fire look-out station on Lassen had not yet been occupied for the summer season of 1914, but it was the property of the Forest Service and a station of importance. It will be seen then that the interests and resources of the Forestry Service as indicated above were such that reports of volcanic activity on Lassen were investigated at once and definite records kept of the reports brought in to headquarters.

The following extracts are from the report of Forest Supervisor W. J. Rushing to the District Forester at San Francisco, made June 9.

Such wild stories are being circulated concerning Mt. Lassen that I am

[3] The writer wishes to express his appreciation of the assistance and courtesies extended him in connection with his field work not only by District Forester DuBois, of San Francisco, and Supervisor Rushing, of Mineral, but also by various members of the staff in each place.

sending you the results of our observations to date. Saturday, May 30, the first outbreak occurred at 5 P.M. This was witnessed by Bert McKenzie, of Chester, who was looking directly at it when it occurred. Ranger Harvey Abbey investigated it on Sunday, May 31, finding a hole 25 x 40 feet in size and of unknown depth. Sand, rocks as large as a sack of flour, and mud had been ejected. The heavier material was thrown over an area three hundred feet across, while the ash, or cement-like material, was scattered over an area one quarter mile across. . . . No molten material was thrown out at all. 8:05 A.M., June 1, a second outburst occurred, throwing out large quantities of the same material. Some boulders weighing all of a ton were thrown out. The vent was enlarged to 60 × 275 feet. . . . Boerker, Abbey, and Macomber went up June 4, remained on top at the lookout house over night, and came back June 5.

June 8, heavier volumes of steam were noted, and at night apparently another eruption took place, throwing out more ashes or fine material, which could be seen on the new snow.

Heavy volumes of steam are coming out of the vent today. We have watched it carefully and at no time have we been able to see any flame or indication of fire. . . . The vent is about one quarter mile from the fire lookout house, and if it continues eastward, as it has so far, it will finally break out on the east side.

Mr. Ben Macomber, one of the party mentioned in the report above as spending the night on the mountain top, has given the following description of the crater as it was after the early eruptions:

When I saw the new crater on Lassen on June 4 and 5, the vent, by an engineer's tape, measured 275 feet long. It was then in one of the pauses between the heavy explosions. Thick volumes of steam, laden with sulphur smoke, were rising, and cracks were appearing in the ground. From three different places on the edge I looked down into the crater. Sixty or seventy feet down a pile of rocks was visible in the center of the vent, but at either end was a huge dark hole from which the steam clouds poured. The walls were absolutely perpendicular, and around the top were hung with huge icicles formed by the condensation of steam in the chill air of the peak.

On the west side of the crater everything was buried beneath a heavy fall of light gray ash, into which we sank over our boot-tops. So light was this rock powder that it flew into the air at every step. On the east side the same material seemed to have been thrown out in the form of mud and lay frozen hard as rock. What little snow remained near the crater was buried under a layer of stones and boulders. (San Francisco Chronicle, June 28.)

The eruption of June 14 was heavier than any which had preceded it, and the only serious injuries suffered by visitors during the six months covered by this article, occurred during the outburst beginning at 9:45 A.M. Extracts from a letter from Mr. B. F. Loomis written a month after the events gives a brief summary of the experiences of the party that was caught by this eruption, as told to him by the different members.

Mr. Phelp's party had just reached the rim of the old crater and sat down to rest a short time, watching the smoke from the crater, when the eruption began. Without any warning or explosion that could be heard, a huge column of black smoke shot upward with a roar, such as would be caused by a rushing mighty wind, and in an instant the air was filled with smoke, ashes and flying rocks

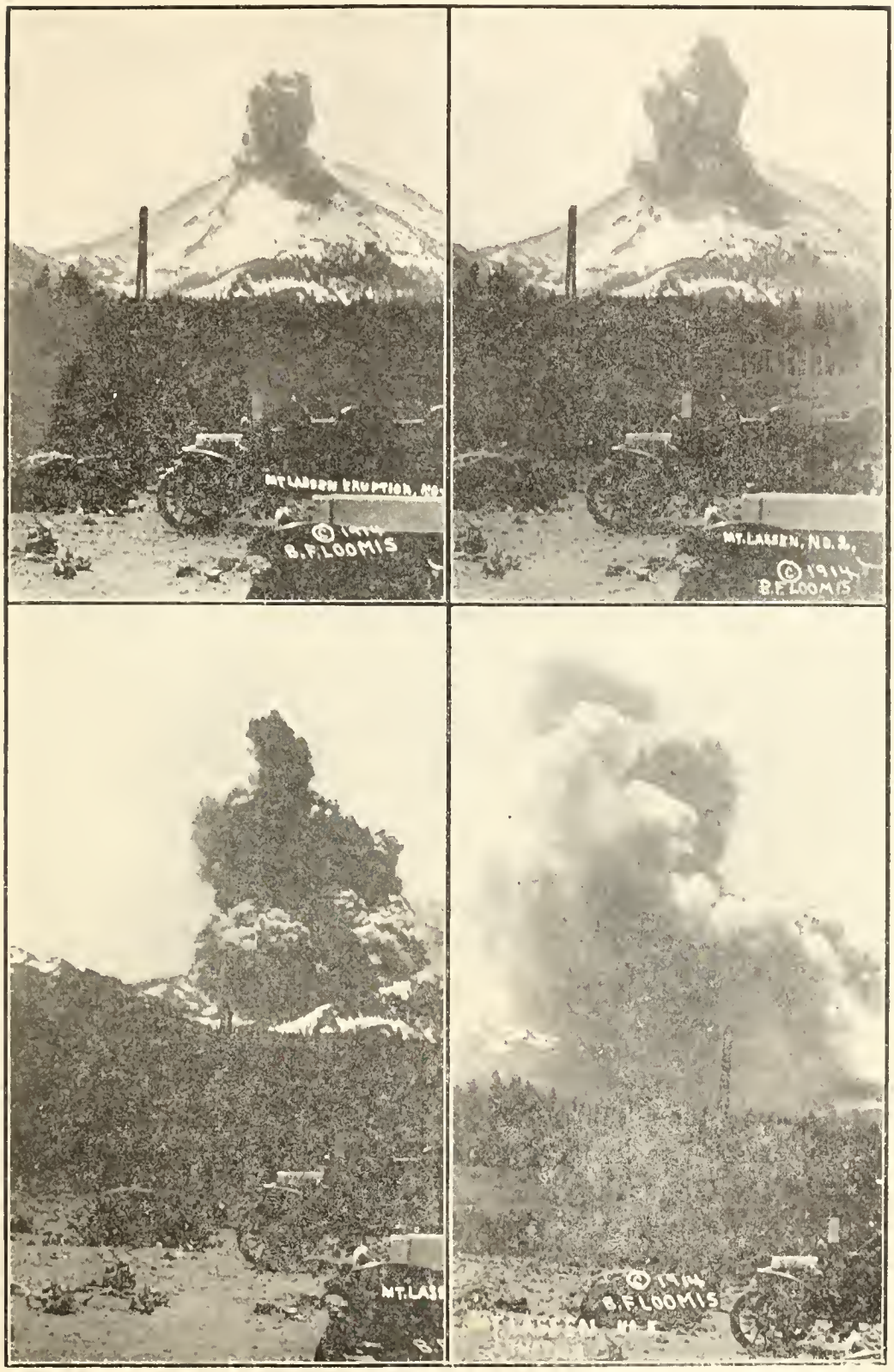


FIG. 2. THE ERUPTION OF JUNE 14, 1914. This series, showing four stages in the eruption beginning at 9:45 a. m., was obtained by Mr. B. F. Loomis, of Viola, from a point about six miles to the northwest at an elevation of nearly 5,000 feet. The time interval represented by the four views of the plate is about fifteen minutes.

from the crater. They all ran for their lives. Mr. Phelps hid under an overhanging rock, which sheltered him from the rocks which brushed past him as they fell. Lance Graham was a few feet away and was struck by a flying rock, which cut a great gash in his shoulder, piercing the thoracic cavity, and broke his collarbone. He was left on the mountain for dead for a time, but was afterward removed with great difficulty, and is now recovered. Another of their party ran down the mountain and, coming to a snowdrift, slid down the mountain like a shot. The cloud of smoke kept pace with him, and when he reached the bottom of the snowdrift he found a clump of bushes and, diving into it, buried his face in the snow to keep out the blinding smoke and ashes. The smoke is described as causing the blackest darkness, black as the darkest night.

The six photographs taken of this eruption by Mr. Loomis from a point at an elevation of about 5,000 feet and nearly six miles to the northwest of Lassen Peak are among the best that have been taken. The view reproduced in figure 2 is number three of the series and shows the steam and ash at about one half the height to which they were projected some ten or fifteen minutes later.

The writer's first trip to the mountain since the eruptions began was made by the Southern Pacific railroad to Red Bluff, thence by stage to Morgan Springs, a resort nine miles southerly in an air line from the peak and located in a valley nearly 5,000 feet above the sea. The week from June 21 to 28 during which no eruption occurred was spent on the mountain or at its base. Some of the hot springs and solfataras at the base of Lassen Peak were visited on the twenty-first and found to exhibit no unusual activity (see Figs. 7 and 8). From June 23 to 25, rainstorms, with snow on the higher levels, prevented a visit to the crater, with any possibility of photographic work. On the twenty-sixth, and the twenty-eighth, the sky was clear, and the new crater was visited and photographed from various points of view. Both trips were made from the hotel at Morgan as a base. The ride on horseback to the foot of the volcanic cone proper at that time took almost four hours, the latter half being over snow from ten to twenty feet deep. After leaving the horses the climb to the top can be made in less than an hour. The new crater has frequently been described as being located on the south slope of the north peak: this peak, however, is merely a fragment of the northern portion of the walls of the ancient crater. The relations of the new opening to the old volcano are better appreciated by describing it as an opening not in the center, but on the north side of the much eroded bowl of the crater. The central depression of the old crater is probably over three hundred feet below the higher points of the old rim. The wall of the old crater has been deeply breached both on the east and on the west, and in summer the melting snow in the depression now drains westward, although there is not enough surface water to make any regular channel. Volcanic dust or "ash" from the different eruptions has been reported as falling from ten to twenty miles from the peak, the amount and direction varying with the wind.

The limit of the heavy fall of ash not wind-borne was quite definitely marked on June 26 and was probably within a circle of less than a mile. It had not, however, a uniform border. In making the ascent on that day, instead of the regular trail a more easterly route was taken, leading up the southeasterly ridge directly to the fire lookout station. This ridge, which lies in the general direction of the longitudinal opening of the crater itself, was found to be much more heavily covered with ash than the regular trail. While the main outbursts were usually directly upward in the eruption described, irregular streaks of ash such as the one just noted prove that there were minor outshoots of volcanic dust in various directions. Exaggerated reports of the distance to which stones were thrown seem to have been based upon their being

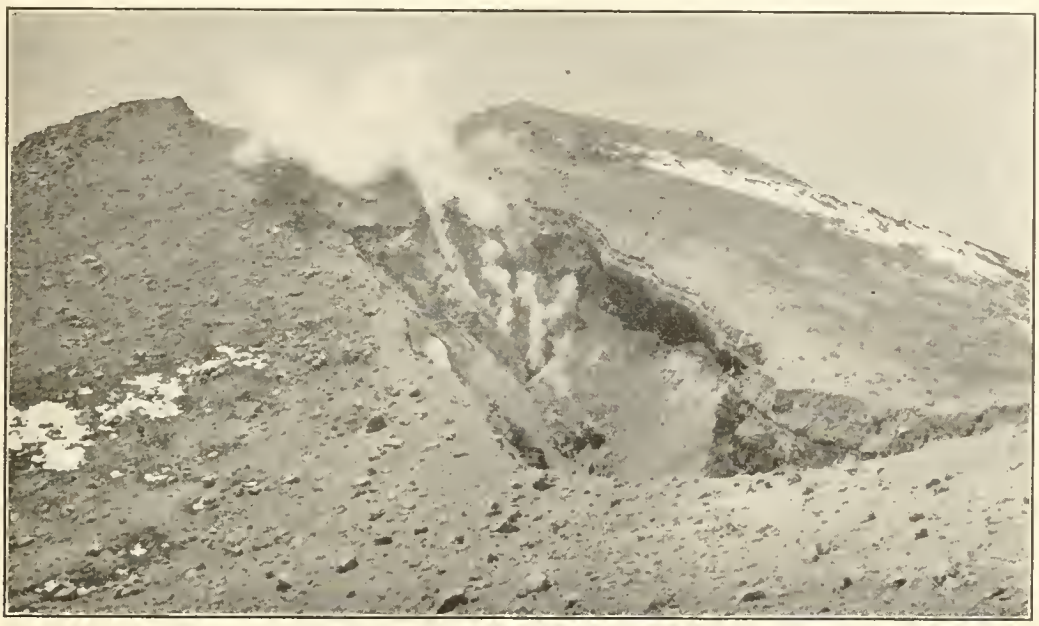


FIG. 3. THE NORTHWESTERLY END OF THE CRATER ON JUNE 28. Whenever the steam was blown aside, a crack was visible extending in the line of steam jets.

found on the outer slopes of the old crater resting upon the surface of the snow, but the fact that stones are constantly being dislodged from the cliffs by ordinary weathering processes and are rolling down the mountain side shows the need of additional criteria. To avoid mistaking such stones for those thrown through the air by eruption, careful search was made on level patches of the old snow so located that it was impossible for stones to roll down upon them. Wherever such level surfaces were found there was no evidence at that time of ejected stones falling at a much greater distance than to the lookout house, certainly at no point over a half mile from the crater.

In climbing Lassen Peak from the southeast up to the crag upon which the Forest Service station is built the slope is so steep and rugged that the final ascent is made without any glimpse of what is ahead. As the last rocks are scaled and one stands on the wind-swept crag by the fragments of the little frame building once bound down to the rocks by

wire cables there suddenly yawns below the climber the bowl of the ancient crater, and he looks directly into the irregular naked chasm of the new vent torn in the opposite slope (Fig. 3). It is impossible for a camera with its narrow field of view to give correct impressions of the conditions of the mountain top. The observer standing upon that solitary, sharp, rocky pinnacle, although he narrows his vision to the new crater steaming below, is conscious of the steep slopes behind him and he also sees subconsciously the surrounding ragged edge of the bowl of the ancient crater.

Descending into the irregular basin, the new vent was photographed at closer range from various directions. No appreciable change occurred between June 26 and June 28, except the rapid disappearance of the new snow as a result of the warmer weather. The northwesterly end of the new crater (Fig. 2) was of most interest because of escaping steam. On close approach, the sulphur fumes became oppressive and yellow sulphur deposits near the vents were distinctly noticeable. The crater was apparently being extended longitudinally along cracks at either end. The northern wall showed also a transverse crack running back from the vent more than a hundred feet. The depth of the crater did not seem to be over eighty feet, but the continually caving sides suggested that the present bottom is but piled up debris. No suggestion could be obtained of the depth of the holes from which steam was escaping. By pacing a line parallel to the side and some fifty feet distant the length of the crater on June 28 was estimated at somewhat more than four hundred feet. This estimate is less than that given by some observers, but agrees closely with that made by Mr. Diller on June 20.

During the last week in July the writer again spent several days at the base of Lassen, this time approaching the mountain by the Susanville auto road which terminates at Drakesbad, a resort in Hot Springs Valley at the southeastern base of the peak. Unfortunately, the time of the second visit proved to be a period of quiescence, as had the first. In the month since the previous visit thirteen eruptions had taken place, the one on July 18 being reported by the Forest Service as "by far the most violent eruption to date. Ash, steam, etc., arose to a height of 11,000 feet. Duration practically the entire morning." Newspaper accounts of this eruption stated that the crater had been greatly enlarged yet the writer's photographs of July 25 compared with those taken June 26, with the same camera and from the same viewpoint were strikingly similar at first glance. Careful comparison indicated a lengthening of the crater of from forty to sixty feet and a proportionate widening, but the general shape and appearance were similar. The linear extension of the crater was evidently along the same crack marked by the steam jets in the June photograph (Fig. 3), and a sharp

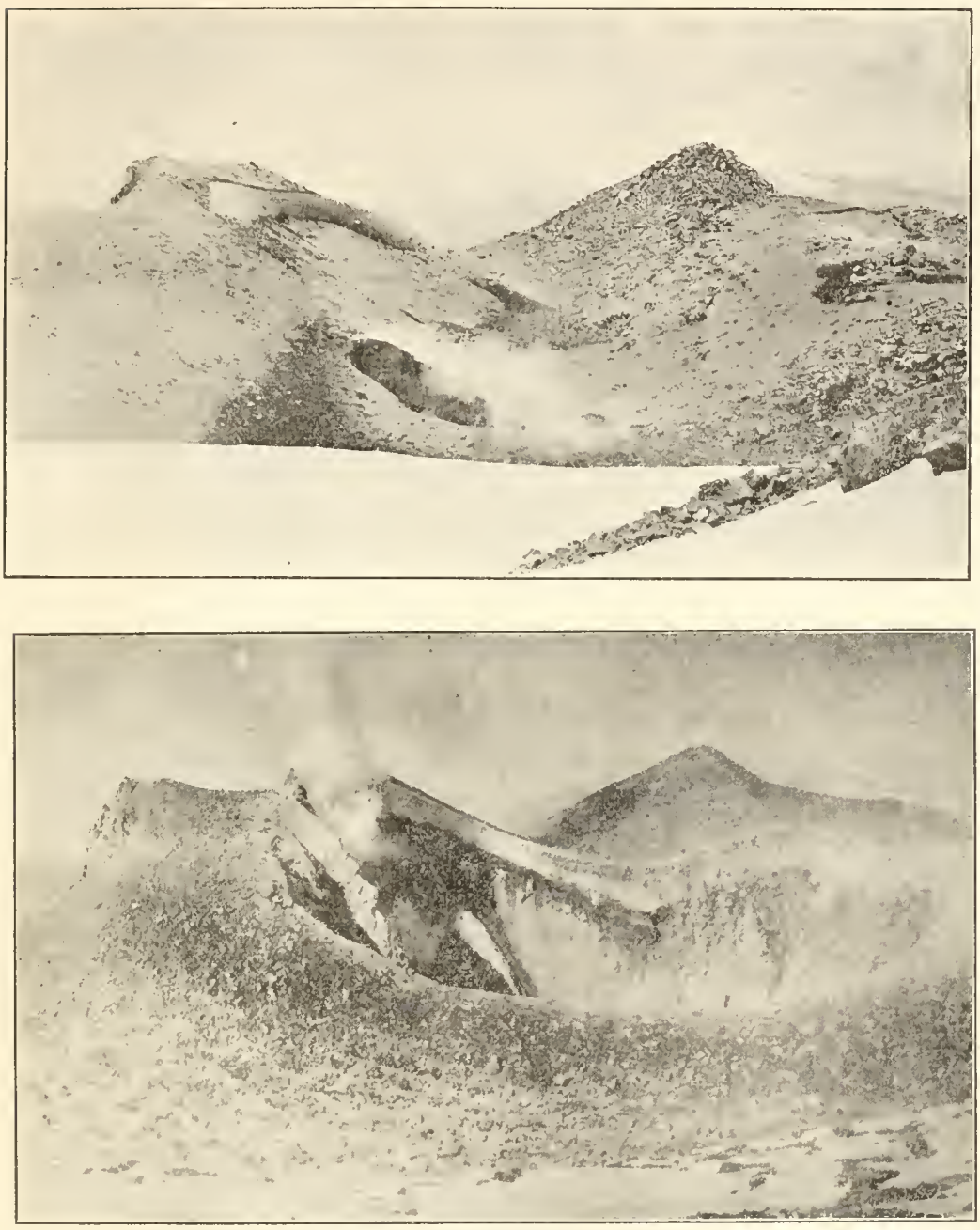


FIG. 4. GRADUAL ENLARGEMENT OF THE FIRST CRATER DEVELOPED ON LASSEN PEAK DURING THE ERUPTIONS OF 1914. (*a*) (above) the new crater on June 4, 1914. Photograph by R. H. Boerker. (Below) (*b*) the crater on July 25, 1914.

notch in the northern end suggested that the movement was likely to continue.

The winter's snow had largely disappeared, although the trail still passed over deep snow banks for nearly a mile in crossing the plateau-like shoulder at the south base of the peak proper. Near the top of the mountain snow was to be found only in patches and beneath the covering of ashes. Such areas moist from the melting snow, from a distance appeared almost black in comparison with the light gray of the dry dust found over the greater part of the mountain. This dust was so fine that it was easily moved by the wind. At times a strong gust would send immense clouds into the air, giving the appearance of an

eruption to casual observers at a distance. With the intense sunshine of a July day at that elevation and with the dry air marked differences in temperature occurred between sunlight and shadow and between wet and dry areas. Under these circumstances strong whirlwinds developed at intervals which sent the dust high into the air in columns strongly resembling steam jets. In fact, the writer when within two miles of the peak on July 25 for a time mistook them for new steam vents, all the more readily since they were situated along the line of reported extensions of the crater. Actual inspection of the area showed the real character of the columns and also that no new vents had been formed in that locality. Probably several of the incorrect reports of eruptions and of new craters came from the same failure to distinguish wind-formed dust clouds from steam explosions.

During the month of August there were but eight eruptions, fewer than either of the preceding months, and seven of the eight, all quite severe occurred August 19–23, inclusive, two of them throwing ash columns to a height of over 10,000 feet. The record for September shows seventeen eruptions, the largest number for any of the six months covered by the tabular list. During the month there was a continuous enlargement of the vent within the basin of the old crater and there were also new vents opened (see Fig. 4) on the outer slopes of the main cone. These vents are clearly identified from photographs taken by Mr. Jack Robertson of Oakland as being in line with the main axis of the first opening. Mr. Robertson had an interesting experience. He was at Drakesbad on the evening of September 19 when he heard a "tremendous explosion" during the night. The next morning he climbed the mountain and had the good fortune to watch at close range the eruption beginning at 11:30 A.M. (eruption no. 46) without receiving any serious injury. The crater was belching smoke at short intervals every few minutes and while he was quite near, steam and ashes poured out from its entire length. The ashes were so hot that they burned his feet as he walked over them. He reports having heard the roar and rumble of the explosions, but was not conscious of any apparent quaking of the ground.

The most marked changes in the new crater since the middle of June occurred during the month of September. The inner vent is reported to have grown to 900 feet in length and photographs taken early in October show that the area of the opening had become fully five times its area at the end of June. The severity of the September eruptions is also attested by the fact the lookout house (Fig. 5 and 6) was completely demolished on the twenty-ninth, no part of the walls being left standing. During the same eruption the forest lookout on Turner Mountain distinctly saw luminous bodies thrown out which appeared to him to be red-hot stones. This report is con-

FIG. 5. THE FIRE LOOKOUT STATION OF THE U. S. FOREST SERVICE ON JUNE 26, 1914. The holes in the roof were probably made during the eruption of June 14. The house has been entirely destroyed by later eruptions.

firmed by other observers, some of whom declare they saw flames. So far as known to the writer, this is the only reliable observation during these eruptions which may possibly be interpreted as indicating that there has ever been an approach to the temperature of molten lava. The coming of winter with frequent snowstorms at that elevation has prevented any search for ejected rocks bearing any evidence of recent subjection to great heat, and consequently the character of the luminous bodies remains undetermined.

The maximum severity for the entire period apparently occurred in September, but this is uncertain, since the record for October and No-

FIG. 6. THE LOOKOUT STATION AS SEEN ON OCTOBER 7.

vember is doubtless far from complete—the region extending from 15 to 20 miles around the mountain being almost if not entirely deserted by the last of October. The resort at Drakesbad at the southeastern base of the mountain closed for the season on September 21 and the headquarters of the forest service were removed to Red Bluff on October 12. The houses on the stock ranches in the vicinity are also deserted during the winter and the few wagon roads are blocked by deep snow until late in spring. Under the conditions indicated, the fact that October and November together are credited with but sixteen recorded eruptions furnishes no basis for any inference that volcanic activity on Lassen Peak is decreasing. At the date of reading proof the activity continues. A dispatch published in the *San Francisco Chronicle*, January 23, 1915, describes an eruption from a new crater on the east as equal to any which have gone before. The dispatch adds that no one has visited the volcano's summit for over two months.

An interesting suggestion concerning the November record comes in a private letter from Mr. Rushing. The eruptions from the summit which were observed during November were all ranked as medium in severity. The suggestion is that this may be explained by the fact that a new vent has been opened at a much lower level. The eruption of November 18 as seen by two observers at stations situated north of west from Lassen came from a point on the north slope of the mountain about a mile from the top and presumably near timber line. A comparison of distant observations from the north and from the south may soon test the correctness of this supposition.

Some further idea of the magnitude of the eruptions of Lassen Peak may be gained from the record of distant observers. A letter from Professor Charles F. Shaw, who was at Amadee about 65 miles eastward from Lassen Peak on October 23, contains particularly interesting observations. The eruption began at 5:40 P.M. The mountain showed plainly over the tops of the nearer hills and the smoke of the eruption was clearly silhouetted against the western sky, extending directly upward from the peak.

> The smoke rolled up until practically the entire height [12,000 ft.; see list of eruptions] was reached before any change in form occurred, when just below the top of the column there was a tendency to stratification and a layer extended out toward the south and toward the north. When this appeared, the smoke column began to lean toward the north and from our point of vision, apparently toward the northeast and with this inclination of the column, distortion took place, the upper part spreading out into streamers. As soon as the inclination of the smoke column became very plain, we could readily distinguish indications of falling material. The lower two thirds of the column seemed to be dropping some material that was falling in a slightly oblique line, the obliqueness pointing back toward the mountain peak. As the eruption continued and the smoke column blew out more toward the north, the streaked condition indicating falling material became more and more apparent, but as the light was failing it became rather hard to distinguish the exact outlines of the lower portion of the column.

FIG. 7. SOUPAN SPRINGS SOUTHWEST OF LASSEN PEAK.

The falling matter must have been the stones and coarser material in distinction from the fine ash forming the top of the column of smoke. Professor Shaw's observation is the only one received by the writer that indicates the height to which the heavier fragments were thrown. "Two thirds" of the column would indicate a height of 8,000 feet.

There seems to be entire agreement by all the competent observers who were fortunately situated that in none of the eruptions has there been any molten lava emitted. Sunset glow upon the steam clouds has most probably accounted for some of the "flames" reported to the newspapers. Samples of the ash were submitted to Professor A. S. Eakle, of the Mineralogy Department of the University of California, and his report follows.

FIG. 8. TARTARUS LAKE (BOILING LAKE) IN HOT SPRING VALLEY.

An examination of the dust from the volcanic eruption of Mt. Lassen shows it to be made up of fine dust and broken fragments of an acid volcanic rock which has been shattered to pieces by a violent explosion. Under the microscope there are to be seen many small angular fragments of quartz, pieces of triclinic feldspar showing twinning structure, perhaps oligoclase in composition frayed sections of brown biotite and grains of magnetite. The original rock could not have been more basic than a dacite and the presence of so much quartz rather suggests a rhyolite. The dust is not an ash in the sense of being a fine residual product of a cinder and there is no evidence of its having come from the cooling of a molten mass. The original rock seems from the appearance of the largest fragments to have been a volcanic tuff formed at some previous activity of the volcano, and the late eruption has simply blown this tuff to dust.

The eruptions of Mt. Lassen while volcanic in their general classification are in the same category as geyser eruptions the difference existing mainly in the fact that the explosions of pent-up steam are so violent as to shatter and throw rock debris in the form of boulders and dust. It is a question whether the explosions are very deep seated.

Some of the mud from the locality is of the same nature as the dust and probably formed from it.

Numerous inquiries have come to the writer as to whether the eruptions of Lassen Peak are to be considered as truly volcanic, and Professor Eakle indirectly raises the same point. This is naturally a question of definition merely. A volcano is primarily an opening in the ground from which the internal forces of the earth project various materials, molten rock being an essential product *at some period* in the history of the volcano.

Many of the type examples of volcanic eruptions given in standard college text-books are, however, of the explosive type, in which no molten lava is ejected. The noted eruption of Bandai-San in Japan, on July 15, 1888, is an instance. This old volcanic cone, nearly 180 miles from Yokohama, had been without sign of life for a thousand years of recorded history, yet with only a few minutes of warning consisting of rumblings and moderate earthquake shocks the entire top of the mountain was blown away in some fifteen to twenty explosions lasting less than a half hour. There was no fresh lava or pumice thrown out. Ash and steam were projected upward about 4,000 feet, but the main force of the explosion was nearly horizontal, carrying destruction in a northerly direction for about four miles. The quantity of material blown away has been estimated at one third of a cubic mile.

In the case of Lassen Peak the period of quiescence had probably been greater than a thousand years, judging from the effect of erosion on the old cone. The force of the steam explosions to date has been distributed through six months, yet the height of the ash-laden column has several times reached two miles above the mountains. Had the steam been confined more effectively in Lassen and the force, instead

of being gradually liberated during the six months, been freed during a few minutes, the results would undoubtedly have been comparable to those at Bandai-San. The point, however, is that the difference is qualitative merely and that the nature and magnitude of the eruptions of Lassen Peak fully justify classing them as volcanic.

A study of the tabular summary of the eruptions gives little upon which to base an opinion as to whether the future will bring a fresh lava flow or whether there is being formed a new solfataric basin. The longest period of quiescence was from July 18 to August 10, twenty-three days. The eruptions in November, so far as observations have been made, do not differ materially from those in June. The fact that Soupan Hot Springs, Morgan Hot Springs and those in Hot Springs Valley are situated in valleys at so much lower levels than the new crater, and are apparently unconnected with Lassen, suggests the idea that the recent activity was due to a column of lava working its way upward along the core of the main peak and that this lava may yet issue as a surface flow. It is confessed, however, that the idea is based more on hope than on any scientific data. A visit in July to Bumpass' Hell showed a crater-like depression filled with hot springs, boiling mud pots, and solfataras, yet it is situated on the crest of a high ridge, some two or three thousand feet above Hot Springs Valley and Morgan Hot Springs. The longest diameter of the oval depression is about a quarter of a mile and the height of walls and general appearance are similar to those of the old crater on Lassen Peak. There was no indication that fresh lava flows had ever issued from the crater of Bumpass' Hell; on the contrary, there was strong suggestion that the depression had developed in the old lava by a process the initial stages of which must have strongly resembled the present condition of Lassen Peak.

If the writer were to offer any forecast it would be that the changes going on at the top of Lassen seem likely to form a solfataric basin of the same general character as that of Bumpass' Hell. However, while there is volcanic life there is a possibility of renewed lava flows. Meantime the physiographer has an opportunity of seeing within the United States, at least one phase of volcanic activity and that on a mountain recently occupied by alpine glaciers and standing in a great lava flow studded with minor volcanic cones, many of them almost untouched by erosion—the whole offering a most inviting field for scientific investigation.

DR. W. W. CAMPBELL.

Director of the Lick Observatory, President of the American Association for the Advancement of Science.

THE PROGRESS OF SCIENCE

SCIENCE ON THE PACIFIC COAST

PROGRESS in science has always been controlled by circumstance. Had Harvey possessed the microscope that a few years after his demonstration of the circulation of the blood Malpighi was applying with distinguished success to the investigation of anatomical problems, he would not have failed to see the capillary network that escaped his unaided eye. And it is a question whether Darwin would have opened the famous notebooks that led after twenty years to the "Origin of Species" had he not been struck by the distribution of animals in South America and the Galapagos Archipelago. The embryology of *Amphioxus* gives obvious support to theories of the formation of the germ layers and of the mesoderm by coelomic pouches that no student of earthworms alone, however diligent, could have constructed. And there is little doubt that Mendel's choice of the garden pea for his investigations on hybridization was a most potent factor in leading him so definitely and speedily to the annunciation of the well-known propositions which have changed the entire course of researches in heredity during the last fifteen years. To the student of physics, the facts of nature assume a quantitative aspect that students of biology are only here and there beginning to recognize. Similarly, the sociologist and the psychologist are now dependent upon biological facts which have lost for the biologist much of their original interest through the development of problems that demand investigation of still more fundamental mechanisms. In the domain of a single science one finds the same connection between experience and ideas. To the investigator of the more generalized types of organisms that respond readily to a wide range of environmental conditions, the laws formulated by investigators of more complex and less plastic organisms seem strangely inadequate: while to the investigator who has discovered them they possess a clarity of outline that affords a welcome substitute for more vaguely expressed, even though more fundamental, conclusions. His eyes filled with the images of secondary adaptations in nature, a behaviorist may formulate his explanations in terms of selection and survival. Whereupon he meets with spirited opposition from the physiologist whose passion it is to reduce vital phenomena to the mechanical terms that have already succeeded in freeing physics and chemistry from the clutch of anthropomorphism.

To understand the Pacific states it is necessary to keep in mind this essential fact, that ideas are dominated by experience. Geologically, geographically, faunistically, socially, economically, the Pacific states form a natural empire distinctly set off from the rest of the country. Mountains and deserts have determined for them a certain isolation that has governed their settlement, the character of their population, whether plant or animal, the development of their institutions, their scientific progress. The region is not only new, but possesses many characteristics that do not ordinarily belong to the experience of citizens of other states.

Some of these recognition marks it is the purpose of this number to consider. The much-vaunted climate of California runs the gamut from typical desert conditions to Alpine, from regions of almost hopeless aridity to regions where humidity becomes an extreme in the other direction. Such diversity is strikingly correlated with floral peculiarities, as one of the papers in this number will show. Under the atmospheric conditions of central and southern California are found the two

DR. EUGENE WOLDEMAR HILGARD,

Professor emeritus of agriculture in the University of California. From a bust presented to the university on the occasion of the dedication of the Agricultural Building.

most important astronomical research institutions in the world. The waters of the Pacific ocean teem with life which forms a rich material background for the investigations of the marine naturalist that can be prosecuted under unusually favorable climatic conditions. This accounts for the presence of a chain of biological laboratories stretching from San Diego to Puget Sound. In the Mohave Desert, fossils have recently been discovered that throw important light upon the evolution of animal forms in the old as well as in the new world. Northern California possesses not only the one active volcano in the limits of the United States but has long harbored the last living representative, for years unknown and neglected, of a tribe of Indians that, in contact for half a century with the frontiers of civilization, continued to live the life of the stone age. It is doubtful whether this remarkable contrast of cultures shows itself anywhere else in our country.

The barriers that have isolated the Pacific coast have more or less successfully shut out tradition. The freedom with which social and political experiments have been made in this region is only paralleled by the experimentation that has drawn the eyes of the world to the pioneer communities of New Zealand and Australia. That freedom to experiment which is the life of science, the necessary companion to discovery, is usually denied in our older communities to social and political pioneers. Whether for good or ill, the citizens of the Pacific states have in numerous cases voted themselves this freedom. The impressive record of the fruits of their boldness will speak in this number for itself.

The Panama Canal will break in upon a certain long remoteness. It will overcome geographical barriers. It will bring new elements to the population that will inevitably produce effects upon social and political institutions. What effects and how? The west is awaiting this new experiment with keen zest and high hopefulness.

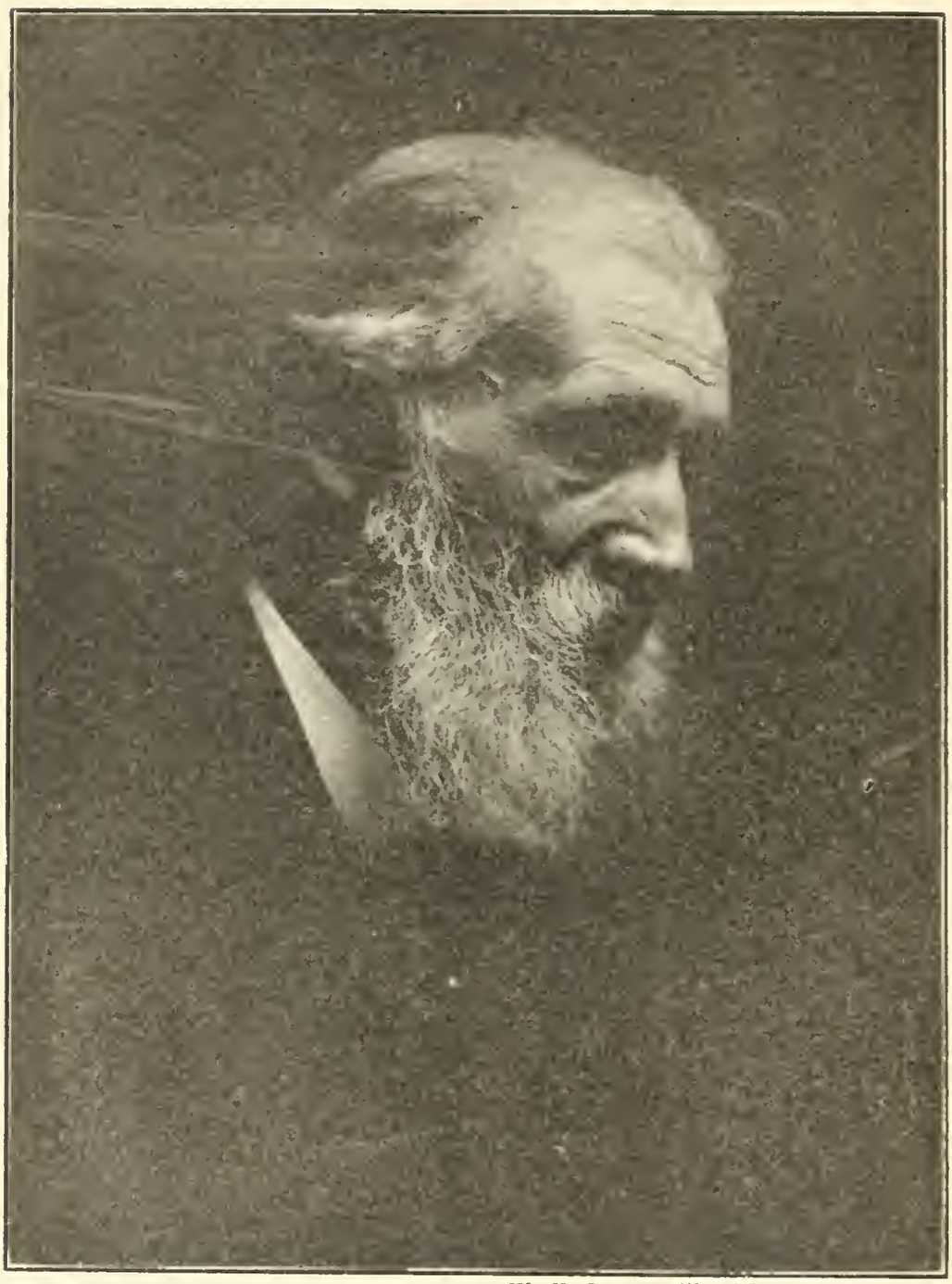
THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SINCE the Pacific coast of the United States is remote from the centers of population of this country, it has been difficult for members of the American Association living within this area to attend the annual meetings in eastern cities. Meanwhile, members on the Pacific coast have made substantial contributions to the progress of science, and the strength of their interest in organized science has been shown by the federation of sixteen societies organized within this region into the Pacific Association of Scientific Societies about four years ago. Four successful annual meetings of the Pacific Association have been held, one at Stanford University, Palo Alto, California, two at the University of California, Berkeley and the latest meeting in May, 1914, at the University of Washington, Seattle.

In extending the work of the American Association actively on the Pacific coast it was felt that any new organization must cooperate with the work of organizations already on the ground. Plans for the merging of the Pacific Association of Scientific Societies with a Pacific Division of the American Association have accordingly been completed. A constitution drafted for the Pacific Division has been approved by the American Association and ratified by eleven of the constituent societies of the Pacific Association.

The affairs of the Pacific Division have been placed in charge of the Pacific Coast Committee of the American Association of which the chairman is Dr. W. W. Campbell, director of the Lick Observatory, and president of the American Association for 1915. The first meeting of the Pacific Division will be held in 1916, and thereafter annual meetings will occur successively in the cities west of the Rocky Mountains.

The Pacific Division as an organization consists of all members of the American Association residing within



W. E. Dassonville, Photographer.

JOHN MUIR.

The Naturalist of the Pacific Coast, Student of Wilderness, whose recent death is deplored by all those interested in science and letters.

the states of Washington, Oregon, California, Idaho, Utah, Nevada and Arizona; in Mexico, Alaska, the Hawaiian and Philippine Islands. No fee is assessed upon members of the Pacific Division in addition to that paid by regular members elsewhere, and members enjoy all the benefits of relation with the parent body, as well as with the Pacific Division. The various fields of scientific research are represented by affiliations with local scientific societies. Several of these societies are branches of national organizations. Sections of the division may be established in any field not covered by a regularly organized society.

The societies which have already allied themselves with the Pacific Division are: the California Academy of Sciences, the Technical Society of the Pacific Coast, the Seismological Society of America, the Cooper Ornithological Club, the Cordilleran Section of the Geological Society of America, the Pacific Coast Paleontological Society, the Astronomical Society of the Pacific Coast, the Biological Society of the Pacific, the Puget Sound Section of the American Chemical Society, the San Francisco Section of the Archeological Institute of America, and the Pacific Slope Association of Economic Entomologists.

In its scope the Pacific Division purposes to enlist the support of all those within the Pacific region who are interested in scientific matters and to establish affiliations with societies organized in this region for the advancement of scientific work and knowledge.

THE SAN FRANCISCO MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE American Association for the Advancement of Science determined at the Cleveland meeting, in January, 1913, to hold a special meeting in San Francisco and vicinity during the year of the Panama-Pacific International Exposition at San Francisco and of the Panama-California Exposition at San Diego. The Pacific Coast Committee of the American Association in charge of this meeting has chosen the week beginning Monday, August 2, as the time for the meeting. The general sessions will be held in San Francisco, while the joint meetings of sections and of societies and the special meetings of societies will be held at the University of California in Berkeley, and on Wednesday, August 4, at Stanford University, near Palo Alto.

This will be the first meeting of the American Association to be held west of the Rocky Mountains. It will, moreover, be in a sense a part of the celebration commemorating the completion of the Panama Canal. Special attention will be given to investigations of world-wide interest for which materials are to be found upon the borders of the Pacific. Many of the scientific problems of the west, though peculiar to the region, are of very general interest in their bearing upon fundamental questions of research. The program for the San Francisco meeting will be composed to a considerable extent of contributions relating to such questions of far-reaching significance. Discussions of other important scientific topics will also be presented.

The opening session of the meeting will be held at the Scottish Rite Auditorium in San Francisco at 10 A.M., Monday, August 2. A general reception will be tendered the visiting members of the association that evening. Four notable addresses are planned for the general evening sessions of the week. Recent developments in oceanographic research will be presented by Dr. Fridtjof Nansen, of Norway. Professor R. A. Daly, of Harvard University, will offer an address upon geologic and biologic problems of the islands of the south Pacific ocean. Professor W. B. Scott, of Princeton University, will discuss the influence of crustal movement in the region of the Panama Canal on the paleontologic relations of North and South America. Dr. Paul S. Reinsch, American ambassador to

China, will present problems concerning the peoples of the Pacific area. Wednesday evening, August 4, is reserved for dinners of scientific societies.

Several important features will mark the section and society meetings of the week. At a joint session on Tuesday, August 2, of the American Mathematical Society, the American Astronomical Society and Section A of the American Association, Professor C. J. Keyser will give an address upon "The Human Significance of Mathematics," and Dr. George E. Hale, of the Mt. Wilson Solar Observatory, Pasadena, California, will speak upon "The Work of a Modern Observatory."

Sessions in physics will be provided for the discussion, among other topics, of spectroscopic investigations of the physics of the air and of high potential electrical experimentation.

The program of the Geological Society of America will include at least three topics—erosion and deposition in arid climates, diastrophism on the Pacific coast and petrological problems of the Pacific area.

Meetings of the Paleontological Society will provide at the first session a series of four addresses upon the general criteria of correlation. In three following sessions symposia will be held for a comparison of the Triassic, Cretaceous and Miocene faunas of the Pacific coast with those of similar periods in other parts of the world.

The program for zoology will include sessions for the discussion of general problems of zoology, embryology and development, problems of conservation, the rôle of variation and heredity in evolution, recent contributions from the field of protozoology, and questions of geographic distribution and of marine biology.

The botanical sessions will be devoted to problems centering upon gymnosperms, which as a group are so widely distributed over the Pacific coast; upon the relation of plants to light; the geographic distribution of plants with especial reference to the origin of the California flora, and upon marine and freshwater algæ.

Sessions for psychology will probably consider problems of animal psychology, the testing of mental traits and the application of psychology to law and medicine.

The anthropological sessions have been planned in conjunction with the American Anthropological Society and the American Folk-Lore Society. The topics of these sessions will be—race in the Pacific area with especial reference to the origin of the American Indians, the history of civilization in the Pacific area with reference especially to relations between Asia and America and the social aspects of race factors in the Pacific area.

Sessions for political and social science are being planned in support of meetings of several societies organized in these fields which will meet during the week immediately following the convocation week of the American Association.

The sessions for education will be devoted to the scientific study of selected educational problems.

Sessions for agriculture will provide for the discussion of problems of animal husbandry, nutrition and food analysis, agronomy and farm management, soil analysis, agricultural chemistry and fertilizers and horticulture.

Among other organizations which will hold special meetings during the convocation week of the American Association are the Archeological Institute of America, the American Phytopathological Society, the American Genetic Society, and an Entomological Congress under the auspices of several entomological societies. Meetings of several societies devoted to economics and social and political science will occur during the week immediately following. The Association of American Agricultural Colleges and Experiment Stations and several other agricultural societies have also appointed meetings for the second week of August. The later part of the month will be occupied with meetings of the International Education Congress and of the National Education Association.

SCIENTIFIC BOOKS

Walker Prizes in Natural History

By the provisions of the will of the late Dr. William Johnson Walker two prizes are annually offered by the BOSTON SOCIETY OF NATURAL HISTORY for the best memoirs written in the English language, on subjects proposed by a Committee appointed by the Council.

For the best memoir presented a prize of sixty dollars may be awarded; if, however, the memoir be one of marked merit, the amount may be increased to one hundred dollars, at the discretion of the Committee.

For the next best memoir a prize not exceeding fifty dollars may be awarded.

Prizes will not be awarded unless the memoirs presented are of adequate merit.

The competition for these prizes is not restricted, but is open to all.

Attention is especially called to the following points :—

1. In all cases the memoirs are to be based on a considerable body of original and unpublished work, accompanied by a general review of the literature of the subject.

2. Anything in the memoir which shall furnish proof of the identity of the author shall be considered as debarring the essay from competition.

3. Although the awards will be based on their intrinsic merits, preference may be given to memoirs bearing evidence of having been prepared with special reference to competition for these prizes.

4. Each memoir must be accompanied by a sealed envelope enclosing the author's name and superscribed with a motto corresponding to one borne by the manuscript, and must be in the hands of the Secretary on or before March 1st of the year for which the prize is offered.

☞Note the change of date for receipt of manuscripts—March 1st.

5. The Society assumes no responsibility for publication of manuscripts submitted, and publication should not be made before the Annual Meeting of the Society in May.

Subjects for 1915 and 1916:—

Any biological or geological subject.

GLOVER M. ALLEN,
Secretary.

Boston Society of Natural History,
Boston, Mass., U. S. A.

The Popular Science Monthly

Entered in the Post Office in Lancaster, Pa., as second-class matter.

CONTENTS OF THE JANUARY NUMBER

Geography in Russian History. Professor William E. Lingelbach

Geological Methods in Earlier Days. Professor John J. Stevenson.

The Cinchona Botanical Station. Professor Duncan S. Johnson.

The Indian's Health Problem. Dr. Charles A. Eastman.

What Animal Experimentation has done for Children. Dr. Henry Dwight Chapin.

Europe's Dynastic Slaughter House. William J. Roe.

Training for Action. H. W. Farwell.

Delusions. Dr. Shepherd Ivory Franz.

Ductless Glands, Internal Secretions and Hormonic Equilibrium. Dr. Fielding H. Garrison.

The Progress of Science :
The Philadelphia Meeting of the American Association for the Advancement of Science ; Progress of Philosophy ; Scientific Items.

CONTENTS OF THE FEBRUARY NUMBER

A History of Tahiti. Dr. Alfred Goldsborough Mayer.

Popular Misconceptions concerning the Weather. Dr. Andrew H. Palmer.

Ductless Glands, Internal Secretions and Hormonic Equilibrium. Dr. Fielding H. Garrison.

The Ethical Principle in Physical Valuation for Rate Making. E. W. James.

Thought in Science and in Science Teaching. Dr. Benjamin C. Gruenberg.

The Problem for the Rural School. Professor J. B. Sears.

The Evanescence of Facts. Dr. Jonathan Wright.

Foreign Association of National Societies. Professor Edward C. Pickering.

Botanizing Excursions in Borneo. Professor W. W. Campbell.

The Progress of Science :
The Convocation Week Meetings ; The Production of Iron Ore in 1913 ; Sir William Osler ; Scientific Items.

PRESS OF THE NEW ERA PRINTING COMPANY

merit your
by their
has large
Fine adju
and rapid
Other con
scopes fro
Spe
Many mo
on reques
BA
4
New York
Leading ma
Lanterns (E

ARE QUALITY

On the
Character of
Candy Depends
its Fitness
for Gift Making

gents Everywhere
$1.00-50¢-25¢

d Reflecting
Telescopes

nd Portable

hotographic
TIVES

Computed by our associate

Dr. F. R. MOULTON
(*Chicago University*)

OBSERVATORIES

Specula, Planes, Eyepieces, etc.

Photographs and Circulars on request

LOHMANN BROS.
GREENVILLE, OHIO :: :: U. S. A

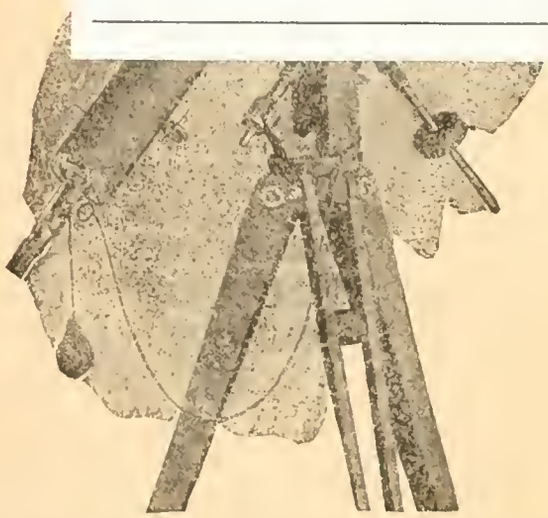


Illustration shows 5-in. with pneumatic clock.